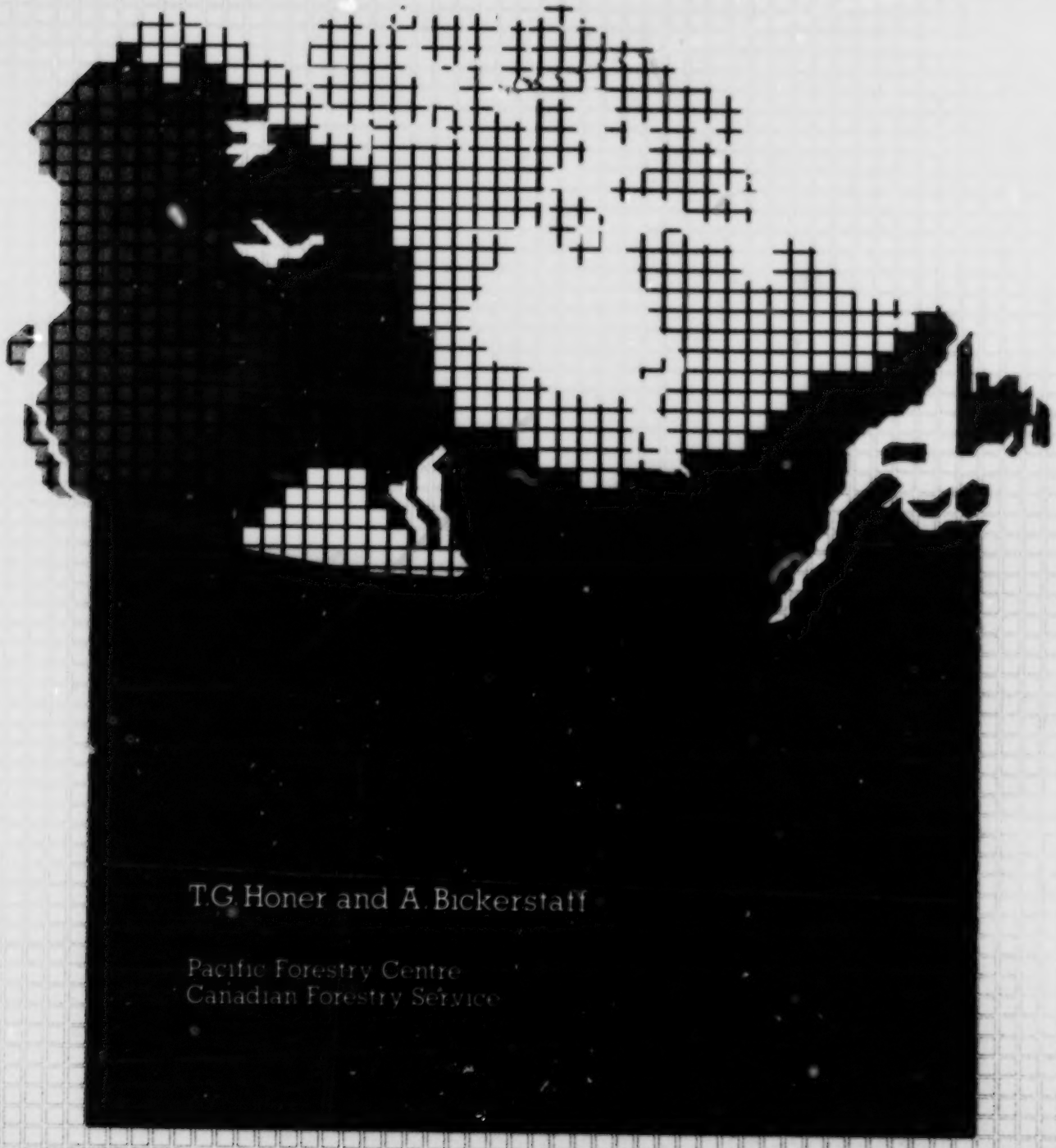
Canada's Forest Area and Wood Volume Balance 1977-1981



T.G. Honer and A. Bickerstaff

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Canada's forest area and wood volume balance 1977-1981:

an appraisal of change under present levels of management

T.G. Honer and A. Bickerstaff

Canadian Forestry Service
Pacific Forestry Centre

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FORSTATS

The FORSTATS (FORestry STATisticS) program provides current statistical information on Canada's forest resources. It produces periodic descriptions and analyses of forest inventory and forest resource dynamics, including forest management activities.

All Canadian Forestry Service establishments contribute to the FORSTATS program, focused at the Petawawa National Forestry Institute. Provincial forestry agencies, other provincial and federal agencies, and the forest industry cooperate in providing data for the program.

Preface

How are Canada's forests performing? Can they continue to support our economy and provide jobs as they have in the past?

Assessing the performance of our forests is not a simple task; forests are dynamic systems and renewal, growth, harvest and destruction are factors that must be carefully interrelated to properly assess change. The practice of forestry must be viewed as a business that should operate within the framework of the regulated or "normal" forest. Many of the data required do not exist. Finally, existing statistics must be presented in a format that permits easy and objective interpretation by the professional and layman alike.

The word "statistic" was first applied to collections of data relating to matters important to the State. But the interpretation of State statistics can be a difficult job and it often raises more problems than the initial collections were designed to solve. Yet, scientists, administrators, businessmen and citizens continue to measure progress by monitoring and assessing statistics on performance.

Detailed statistics on Canada's forests are presented in 29 tables of forest capital, accruals, withdrawals and volume-area status in Appendix 4. The reporting level is the individual province or territory with totals provided for the nation.

We have included chapters on the relationships and management concepts that characterize the forestry system. This will provide the general reader with a framework on resource management that can be used to evaluate and interpret the statistics presented. Those readers that are familiar with resource management concepts may want to skip these chapters and concentrate on our methodology, described in Appendix II, before undertaking a detailed assessment of Canada's forest capital, accruals and withdrawals.

Of interest to all readers will be the chapter on the balance of accruals and withdrawals and the resource statements of capital and annual change for Canada's volume of forest growing stock and area of productive forest land. In the final chapters we emphasize the constraints that apply to these data and discuss the implications and policy options open to Canadians for the management of their forests.

We have endeavored to present the information in a factual and objective manner from the perspective of the professional forester. This report is a first attempt to assess the status of Canada's forest resource under present levels of management.

Highlights

A simple model is used to describe Canada's forest resource and the changes that occurred during the period 1977-1981. The forestry system is described within the context of the "Normal Forest," i.e., the ideal forest that provides a sustained yield of primary forest products and is the norm or standard to which Canada's existing forests and level of management can be compared.

A consolidated statement on the forest resource, the changes that occurred during the five-year period and the constraints and policy options reveals that:

Volume capital of Canada's forests

- the volume of the growing stock is 21.5 billion m^3; timber available for harvest comprises 14 billion m^3 and immature and regeneration stands contain about 7.5 billion m^3.

- annual accruals to the growing stock resulting from growth, regeneration and silvicultural activities are about 338 million m^3.

- annual depletion of the growing stock is 287 million m^3; harvest volumes are about 144 million m^3, fires destroy about 80 million m^3 and forest pests kill a volume of about 64 million m^3.

- the average annual balance in the growing stock volume is a net increase of about 51 million m^3. This represents an annual increase in the growing stock of 0.2%.

- an annual volume increment of 38 million m^3 is not realized because a backlog of productive lands are not satisfactorily restocked to commercial tree species.

Land capital of Canada's forests

- the land base for forestry is 221 million ha; about 198 million ha are stocked to commercial tree species.

- annual accruals to stocked land are 1.8 million ha; natural regeneration accounts for 1.6 million ha and artificial regeneration contributes about 0.2 million ha.

- annual withdrawals from stocked land are 2.2 million ha; wild fire and pests account for about 1.5 million ha whereas planned harvesting operations total about 0.8 million ha. No data are available on timber land alienations.

- the annual average balance in stocked forest land is a deficit; about 452 000 ha of productive forest land goes out of production each year.

- for every 100 ha of stocked productive forest land that is either harvested, burned or damaged by forest pests — 8 ha are restocked by planting, 72 ha regenerate naturally, and 20 ha go out of production and are classified as "not satisfactorily restocked."

- the quantity of productive forest land that is out of production as being not satisfactorily restocked to commercial tree species amounts to about 22 million ha or about 10% of the land base for forestry.

- even for those forestry activities for which there are approved management plans, there is an annual deficit; 186 thousand ha of productive forest land goes out of production annually.

Constraints on results

- about 45% of the forest inventory data are more than 10 years old and many have not been updated.

- estimates of forest volume capital, growth, and much of the depletion data are largely ex-

pressed in terms of gross merchantable volume and have not been adjusted for rot, damage and reduced growth.

- merchantable volume standards vary between provinces resulting in national estimates that probably have discrepancies of varying magnitude.

- the data represent the physical supply of land and timber for forestry purposes whereas the land and forest that can be managed in an economic manner is probably much smaller.

A policy option to the year 2000

- maintain the land base for forestry at the 1981 level;

- establish harvesting levels to take advantage of forecasted marketing opportunities for forest products resulting in age class distributions that more closely approximate those of the "Normal Forest";

- exercise a measure of increased control on depletion from fire and forest pests;

- increase planting and silvicultural activities so that all lands devoted to forestry are maintained in a stocked, productive state.

Points saillants

Les auteurs décrivent au moyen d'un modèle simple les ressources forestières du Canada et les changements qu'elles ont subis au cours de la période de 1977 à 1981. Le système forestier est décrit dans le contexte d'une 'forêt normale', c'est-à-dire la forêt idéale qui assure une production soutenue de produits forestiers primaires et qui représente la norme ou l'étalon pour la comparaison des forêts et des conditions d'aménagement au Canada.

Si l'on considère l'ensemble des ressources forestières, les changements qui se sont produits au cours de ces cinq années, les restrictions touchant les données et les lignes de conduite possibles, il est possible de dégager les conclusions suivantes:

Volume des ressources forestières Canadiennes

- Le volume du matériel sur pied s'élève à 21.5 milliards m^3, dont 14 milliards m^3 de bois récoltable; le reste, soit 7.5 milliards m^3, se trouve dans les peuplements non matures et en régénération.

- L'accroissement annuel du matériel sur pied obtenu grâce à la croissance, à la régénération et aux activités sylvicoles se chiffre à environ 338 millions m^3.

- Le dépeuplement est évalué à 287 millions m^3 par année, l'industrie prélevant environ 144 millions m^3, les incendies en détruisant environ 80 millions m^3, et les déprédateurs des forêts, approximativement 64 millions m^3.

- Le bilan annuel moyen des gains et des pertes en volume affiche donc une augmentation nette d'environ 51 millions m^3, ce qui représente une hausse de 0.2 % du matériel sur pied.

- Un volume d'accroissement de 38 millions m^3 par année n'est pas réalisé à cause d'un reboisement insuffisant en essences commerciales des terres productives.

Superficie des terres forestières Canadiennes

- Les terres à destination forestière occupent une superficie de 221 millions ha comprenant 198 millions ha où poussent des essences commerciales.

- Les gains annuels de terres boisées s'élèvent à 1,8 million ha: 1.6 million ha sont obtenus grâce à la régénération naturelle, et environ 0.2 million ha, par les activités de reboisement.

- Les pertes annuelles de terres boisées se chiffrent à 2.2 millions ha; elles sont attribuables pour environ 1.5 million ha aux incendies et aux ravageurs et pour 0.8 million ha aux opérations planifiées de récolte. On n'a pas de données sur les aliénations de terres forestières.

- Le bilan annuel moyen des gains et des pertes accuse un déficit: environ 452 000 ha de terres forestières productives deviennent impropres à la production chaque année.

- Pour 100 ha de terres forestières productives boisées qui sont exploitées, brûlées au endommagées par des déprédateurs, 8 ha sont reboisées par l'homme, 72 ha sont reconstituées naturellement, et 20 ha deviennent impropres à la production et sont classées comme "insuffisamment reboisées".

- La superficie des terres forestières productives qui ne sont pas en production, étant insuffisamment reboisées en essences commerciales, s'élève à 22 millions ha, ce qui correspond à environ 10 % de la superficie des terres à destination forestière.

- Même pour les activités forestières pour

lesquelles il existe des plans approuvés d'aménagement, un déficit annuel est enregistré: 186 000 ha de terres forestières productives deviennent impropres à la production chaque année.

Restrictions touchant les données

- Environ 45 % des données de l'inventaire des forêts datent de plus de 10 ans, et beaucoup de données n'ont pas été mises à jour.
- Les estimations du volume des ressources forestières, de l'accroissement des forêts et du dépeuplement sont en bonne partie exprimées en termes du volume marchand brut et ne sont pas corrigées pour les caries, les dommages et les ralentissements de croissance.
- Les critères pour le volume marchand varient d'une province à l'autre, de sorte que les estimations nationales comportent probablement des erreurs d'importance variée.
- Les données renseignent sur les ressources physiques en terres et en bois dont on dispose pour les activités forestières, mais les terres et les forêts qui peuvent être aménagées de façon économique sont probablement beaucoup moins considérables.

Ligne de conduite proposée pour d'ici l'an 2000

- Maintenir la superficie des terres forestières au niveau de 1981;
- Établir les intensités d'exploitation de façon à tirer profit des possibilités prévues de marché pour les produits forestiers; les répartitions des classes d'âge ressembleront davantage à celles de la "forêt normale";
- Accroître la lutte contre le dépeuplement causé par les incendies et les ravageurs;
- Intensifier le reboisement et les activités sylvicoles afin que toutes les terres à destination forestière soient conservées à l'état boisé et productif.

INTRODUCTION

Is Canada running out of wood?
Are we planting enough trees?
Are we cutting too many?

These are the questions asked by a public concerned about the status of Canada's forest resource. The questions are simple. The answers are difficult to provide.

Statistics on Canada's forests have been published since 1909 but have dealt with specific aspects of the resource. National forest inventory statistics provide estimates of forest land area and standing timber volume. Forest fire statistics are published annually and give information on the number and causes of forest fires. Forest pest reports are published on a regular basis to give some estimates of damage attributable to major insects and diseases. Information on planting and silviculture treatments is now available. Yet the problem of providing meaningful answers to these simple questions still persists.

Even with regularly updated forest inventories, changes in the quantities of land and timber volume reported at different dates cannot be attributed with any certainty to specific factors. Were the changes real or were they artifacts? Did they occur because inventories covered different areas, or because classification systems changed? Or did losses in growing stock from fire and forest pests cause the major changes?

Existing forest inventories, taken at intervals of 10 to 30 years, are not designed to answer such questions. The available statistical data on forest growth, fires, pests and harvests presents detailed information specific to each subject but generally are not related to the inventory. Unless these problem areas can be brought together at a level of integration appropriate to their practical importance, there can be no rational answer to the often asked question, "Is Canada running out of merchantable timber at present levels of utilization and management?"

In 1981, new statistics on the forest resource became available. A new national forest inventory was produced that effectively collates the provincial forestry data under a common standard of classification criteria. A national report on forest growth was published and new five year data on pest losses and fire losses were produced. Thus, it was timely to review these data and assess their utility in describing the periodic change in the forest resource.

The purpose of this report is to describe the forestry system and to present available statistics on the forest resource in a form that will allow the reader to assess the level of resource management in the nation. The concept of the "Normal Forest" and its use in regulating the harvest and in the protection and silvicultural treatment of the resource is discussed. Information is presented on Canada's forest capital, forest growth and depletion. A consolidated statement of the changes in the forest resource for the period 1977-1981 is reported and the results of these analyses are discussed and policy options are evaluated. This report provides a first approximation of changes in the forest resource under present levels of management.

GENERAL RELATIONSHIPS

The ability of any country, province or region to produce primary forest products on a continuing basis is governed by:

- Available area of productive forest land;
- Volume, age and condition of the timber now growing on the land;
- Growth capability of the land and the timber;
- Intensity of forest management;
- Estimated annual allowable cuts (AAC);
- Rates of depletion by fire, pests and natural disasters;
- Constraints upon the economic availability of productive areas and volumes.

Ideally, when technical data are collected on these factors, they form the basis for making objective policy and management decisions regarding the level of harvest that Canada's forests can sustain and the measures necessary to maintain or improve the resource base. In practice the ideal is rarely attained.

Conceptually, the forests are described as a dynamic renewable resource that can be managed and enhanced rather than held as a static reserve of wood capital until required for use. Therefore,

in addition to the conventional description of capital assets in the form of productive forest land and timber volumes, an attempt is made to estimate the current operating balance that exists between the sustainable growth of forests and their depletion through harvesting, fire and other causes.

Forestry, whether practiced by a government, a corporation or a woodlot owner must be viewed as an operating business. To foresters, growth, depletion, growing stock and land are comparable respectively, to what interest or dividends, expenditures, operating capital and fixed assets are to financial managers. Forests like finances must be managed if they are to remain viable and meet the owner's needs or objectives.

The owners of most of the forests in Canada are the provincial and federal governments and they have similar objectives:

- to provide continuing supplies of saleable products from existing forests, and where feasible
- to increase the growth and quality of the natural forest by more intensive silvicultural measures and improved protection, and of increasing importance,
- to integrate wood production with other compatible uses of the forest such as amenity values, wildlife habitat, hunting, fishing, recreation, and watershed protection.

This chapter provides a conceptual and qualitative overview of the forestry components, capital, accruals and depletions and how they are managed to achieve management objectives. Subsequent chapters quantify and evaluate the components and their inter-relationships.

Forest capital

There are two kinds of forest capital. First, there is the available land base for forest production which is considered to be a relatively fixed asset. Secondly, there is the growing stock, or the current inventory of merchantable timber. This is considered as being operating capital.

The land base. The forest land available for wood production is a relatively fixed capital asset although it is often subject to withdrawals for other uses such as agriculture, wilderness areas, parks, and urban or industrial developments. The land base is also subject to increases from the reforestation of sub-marginal agricultural land or other areas. Forest land varies greatly in its inherent capability to grow forests and because of this two categories are used in forest inventories: **nonproductive forest land** made up of open marshes, rock barrens, or scrub forest on muskeg and tundra areas which may be intermixed with the **productive forest land** which can grow commercial forests in a reasonable period of time, e.g., 70 — 100 years. Whether or not productive forest land actually grows forests obviously depends upon it being stocked with sufficient trees to utilize its productive capacity.

Stocked productive forest land is the basic prerequisite for current and future forestry operations; the changes in the area and condition of such lands reflect the success or failure of forest management policies.

Productive forest lands that have been harvested or depleted but not adequately restocked to commercial tree species are often called NSR for "**not satisfactorily restocked**." These are lands that have failed to regenerate adequately within ten years of harvest or destruction of the original stand by fire, pests or natural causes.

Growing stock. The growing stock is the merchantable volume of timber present on the productive land base at a particular time. It is the wood capital available for either current or future use. The youngest stands are those in the regeneration phase and have little or no merchantable volume. That which is immature is held for the future since it is growing rapidly and often is not of sufficient size to be utilized. The mature and overmature stands of timber are available for harvest at any time; their mean annual growth has culminated and their yield (volume per hectare) is near its maximum.

An extremely important characteristic of the growing stock in Canadian forests is that it occurs predominantly in even-aged stands because of a history of fire and harvesting. The species characteristics are such that most of the merchantable trees in a stand usually become established at

about the same time or within about the first twenty years. Because of their similar age and size, all trees are harvested at the same time by some form of clearcutting, and their subsequent regeneration which is achieved either naturally or artificially perpetuates stands of similar age structure.

Physical supply. Inventories of growing stock usually report timber volumes as the physical supply of merchantable wood growing on lands devoted to forest production. These quantities are not all available for product utilization as many of the trees and stands are growing on land that cannot be managed economically and that may be more suitable for wildlife habitat, water-table stability and other uses. At the present time only a few inventories distinguish the economic supply from the physical supply of timber. Since these data are not available for all of Canada, the forest land and volume capital used in this report refers to the physical supply of timber. Changing technology and alternate uses of land may influence future inventories to the extent that the physical supply should approximate that which can be managed economically.

Accruals to capital

Forest growth is the increase in volume of timbered stands that occurs on an annual basis. It is measured in cubic metres per hectare per year and is the equivalent of interest or dividends in dollars per annum. When growth is expressed as a percentage of the growing stock it is similar to the rate of return on bonds or equities.

The capability of productive forest land to grow commercial forests is dependent upon climate, latitude and altitude and locally on soil type and moisture relations. But the amount of growth that takes place in the forest depends upon the quantity and the quality of the growing stock. Thus on areas under forest management, growth is highest on fertile sites that are adequately stocked with vigorous healthy trees up to the age of maturity. Conversely growth is low in areas that are poorly stocked or have a preponderance of poor growing sites. Regardless of site quality, forest growth is extremely low if the growing stock is overmature, since natural mortality may equal or exceed the growth on the trees still living in such stands.

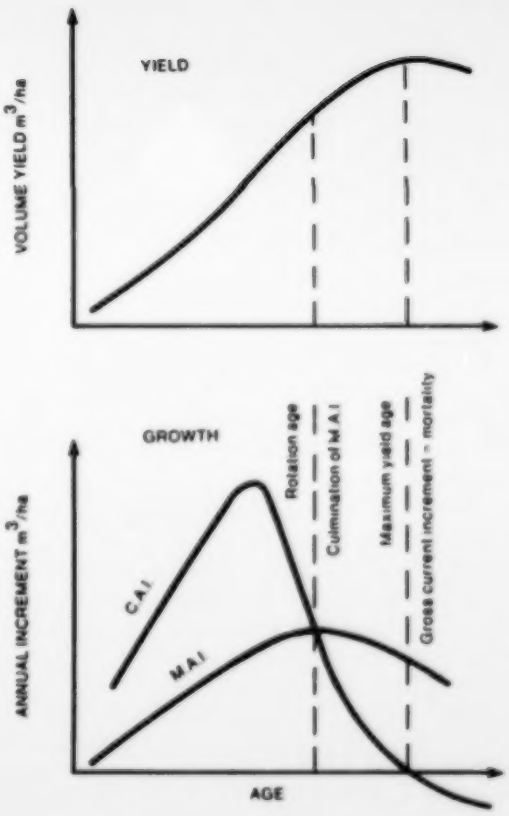

Fig. 1. Growth and Yield of Even-aged Stands.

Yield is the accumulated increment present in the growing stock at a particular age or date, e.g., "70-year-old stands had an average yield of 200 m³/ha." A yield curve (yield over age) and the growth patterns associated with it are shown for a typical even-aged stand in Figure 1.

The figure shows two quite different growth patterns, one for current increment and the other for mean (average) increment. The current annual increment (CAI) is the growth that takes place in a specified year, or annually at a particular age, e.g., in 1981 or at age 70; it is used mainly for short-term yield projections or for evaluating the early effects of silvicultural treatments. Mean annual increment (MAI) is the average annual growth that has occurred up to a given age and is calculated by dividing the yield by the age; it is used for long-term planning and establishing sustainable levels of harvest.

The two measures of growth have a common value at only one point, i.e., the age at which the MAI culminates. This age is the technical rotation age at which stands mature and should be harvested to optimize volume production. The MAI curve is relatively flat for a number of years above and below the rotation age. For this reason and others, the mean annual increment to rotation age (MAI_r) is the measure of long-term growth used in all of the subsequent statistical presentations. This is the growth that can be sustained from existing natural forests when regeneration of depleted areas is ensured.

Withdrawals of forest capital

Withdrawals or depletions reduce the area and volume of the existing growing stock, and take several forms. The harvesting of forest products is a withdrawal that provides a positive economic gain. Depletion through tree mortality from catastrophic disturbances such as fire, insects and disease is an operating loss unless it can be salvaged. The normal mortality that takes place in healthy growing forests is not considered as depletion since there is always a positive net growth providing annual increases to the growing stock until well past rotation age. The reduction of current growth that may occur in pest-infested forests and overmature stands does not reduce the existing growing stock and therefore is not included in depletion.

Planned harvesting and operating withdrawals obviously reduce the growing stock volume but they do not necessarily reduce the land base from which the trees were removed. Losses to the stocked productive forest land base occur only as the result of regeneration failures or withdrawal of land for other uses. Thus, if 50% of the area harvested is regenerated naturally and another 20% is planted, then the loss to the productive land base is the 30% that was not restocked. The first priority of forest management is to minimize this loss.

MANAGEMENT CONCEPTS

General relationships

The organization of diverse forestry components to achieve optimum sustained production involves technical, economic and political considerations which are highly interactive with respect to the constraints they mutually impose. As this report is concerned mainly with the presentation of statistics relating to the physical and technical base for forest management, the economic and political implications are considered only in very general terms and as constraints upon the technical implementation of the concepts.

The principle of sustained yield is fundamental to the practice of forestry: manage the land and the timber on it so that a supply of forest products is available on a continuing basis. For Canada, the problem is to produce a steady supply of primary forest products from the existing relatively unregulated forest. Two extreme examples serve to illustrate the problems involved in bringing the natural forest into a regulated state of production.

Many believe that if the volume of wood harvested is equal to or less than the current growth the continued supplies are assured. However, current annual increment is highest in young immature stands just reaching merchantable size and continues to decline as the stands reach maturity. In the older overmature stands the current growth may be negative as the volume of mortality may even exceed the growth (Figure 1). Thus if young stands predominate in the forest, the harvest may not be economically possible due to low yields and small tree sizes. Conversely, if old stands predominate the resulting harvest would be far below that which the forest is capable of producing.

Another solution, this one based on area rather than volume, suggests, for example, that if black spruce stands take 100 years to reach maturity, then sustained production would be achieved if 1/100 of the area supporting black spruce stands was harvested each year. Once again the approach appears to be a reasonable one. However, if the area contains only young stands, no harvest will be possible for perhaps 50 years. Should the stands be mainly mature and harvested over a 100- year period, there would be serious deterio-

ration and mortality from overmaturity, plus financial losses from carrying unnecessarily high volumes of forest capital with no growth potential.

These two extreme examples serve mainly to emphasize that sustained production can rarely be ensured by balancing the volume of depletion with current growth or harvesting equal areas annually. Among the key elements missing in the solutions is a supply of mature and merchantable timber and a reservoir of stands of young growth and immature age classes in the areas under management. However, it is possible, in theory at least, to have a forest where both of the foregoing simplistic solutions would succeed. Such a unique forest is known in forestry jargon as the "Normal Forest". The Normal Forest provides a conceptual model against which actual forests can be compared and regulated.

The normal forest

The Normal Forest is the traditional forestry concept of heaven — a perfect forest amid a world of imperfect forests. It is the standard against which existing forests are compared and the goal towards which they are directed by foresters. The criteria for perfection are stringent and natural forests under management rarely if ever attain this status in all respects.

To meet the norm or standard, a forest must satisfy the following requirements:

1) Normal stocking: — all areas are fully (100%) stocked with sufficient trees to completely utilize the growth capacity of the site.

2) Normal age-class distribution: all age classes from seedlings to mature stands are represented with each occupying discrete and equal areas.

3) Rotation Age: annual harvesting takes place at maturity; the age at which mean annual increment is at its maximum.

4) Regeneration: all areas harvested are immediately restocked with adequate new growth.

Such a forest is a closed system with all components in dynamic equilibrium but unchanging in magnitude, i.e., the annual cut is equal in volume to the current growth which in turn is equal to the mean annual growth to rotation age, and the cut can be harvested from equal areas annually in perpetuity. The entire forest is renewed during the rotation period with mature trees harvested and replaced by new growth. Only the physical distribution of the growing stock upon the area base changes.

The relationships between components in the Normal Forest are shown schematically in Figure 2, using for purposes of example, a hypothetical forest 8 000 ha in area that takes 80 years to mature with a yield at maturity of 200 m^3/ha. The changes that take place in the spatial distribution of the growing stock during the rotation period are also shown. Equal areas are harvested annually providing a yield of 200 m^3/ha and the harvested land is immediately planted to commercial tree species.

Natural forests

The forests in Canada which are suitable for timber production differ from the conceptual normal forests in several respects. Most of their deviations from normality are detrimental for long-term sustained and optimum production but sometimes the available natural forest has an advantage over the normal, particularly on a short-term basis.

Stocking. Natural forests generally have lower than normal stocking, and the growth potential of the site is not fully utilized. As a result, the mean annual increment and the yield at rotation age are much less than that of the Normal Forest. In Ontario, the actual stocking in stands of the major forest types on average sites ranges from 64% to 85% of normal stocking (Bickerstaff *et al.* 1981). In theory this suggests that the productivity of natural stands could be increased by about 1/3 by careful control of stocking and spacing such as is possible in planted stands under very intensive management.

Age-class distribution. The present distribution of age classes and growing stock within

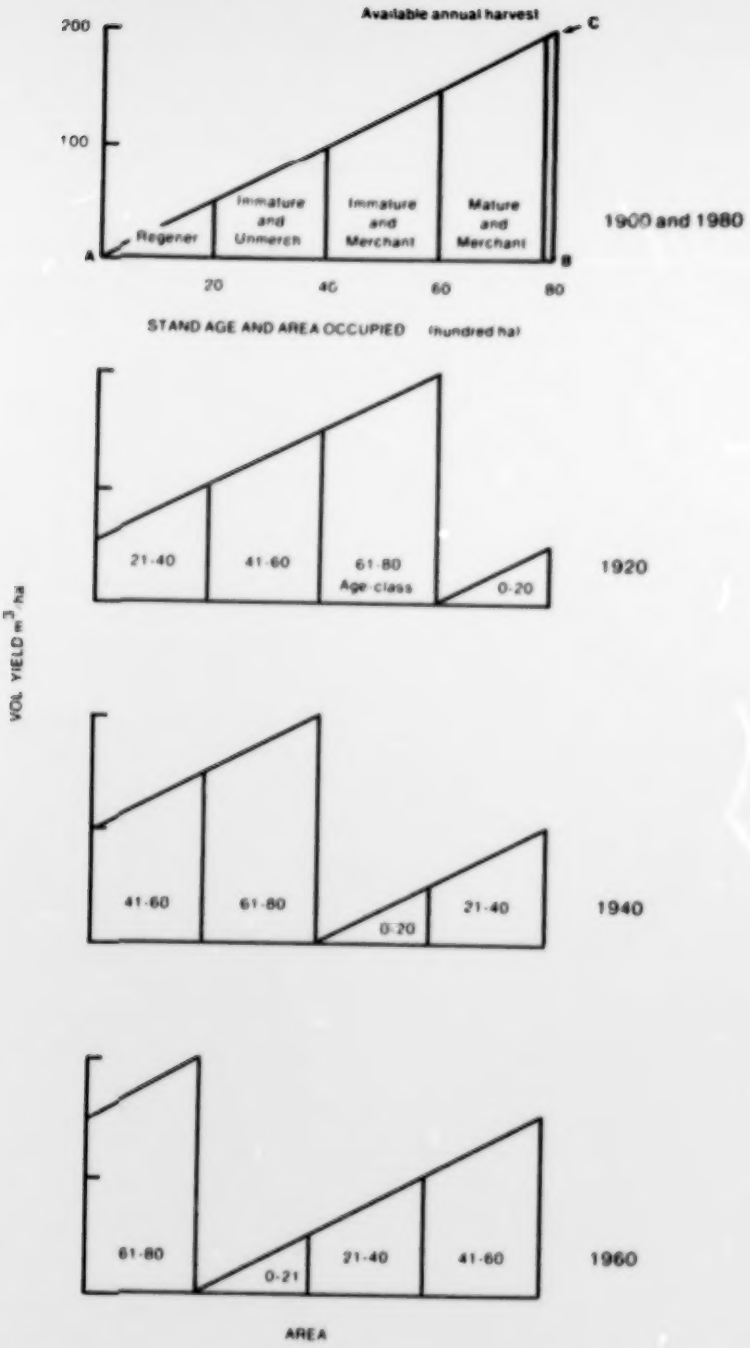

Fig. 2. Schematic representation of a Normal Forest of 8 000 ha assuming a rotation age of 80-years with a yield per hectare at harvest of 200 m^3, showing the relationships that exist over the rotation period.

Canadian forests largely reflects a history of depletion and natural renewal over the last several hundred years. Fire, pests and natural decadence act to deplete the forests on an annual basis but these factors only affect a relatively small portion of the land base. As a result the natural processes of forest growth and renewal produce a forest largely composed of mature and overmature trees. During this century, large-scale commercial harvesting operations have reduced the preponderance of old-growth timber.

Rotation age. In the natural forest, rotation age varies greatly and is dependent upon the product being grown, species characteristics and site quality. Products requiring large unit sizes or high quality, such as veneer and sawlogs, have longer rotations than pulpwood, fuelwood and biomass. Aspen and balsam fir have shorter rotations than the long-lived maple and spruce. Also, highly productive sites have more rapid growth and shorter rotations than poor sites.

On forest management units where all products and species are harvested from a variety of sites, the many possible combinations result in a broad range of theoretically optimum rotation ages. This provides flexibility in grouping stands for harvest and in modifying age-class distributions.

Depletion. In the Normal Forest, depletion is limited to constant harvests of mature timber but in natural forests depletion also includes losses from fire, insects and disease. The control of depletion is the only practical method for altering existing age-class distributions to achieve a closer approach to normality. This can be achieved by improved protection but the greatest control over the forest is exercised by setting the Annual Allowable Cut at the appropriate level.

Allowable cut. The allowable cut is the volume of wood which should be harvested during a given period to meet the owners management objectives. To liquidate an excess of mature and overmature growing stock capital, the allowable cut can be much higher than that which could be sustained on a long-term basis (Figure 3A), whereas low cuts are prescribed to rebuild growing stock which has been badly depleted through overcutting, fire, insects or other causes (Figure 3B). In setting the allowable cut, which is usually expressed on an annual basis for a particular period, the depletion from

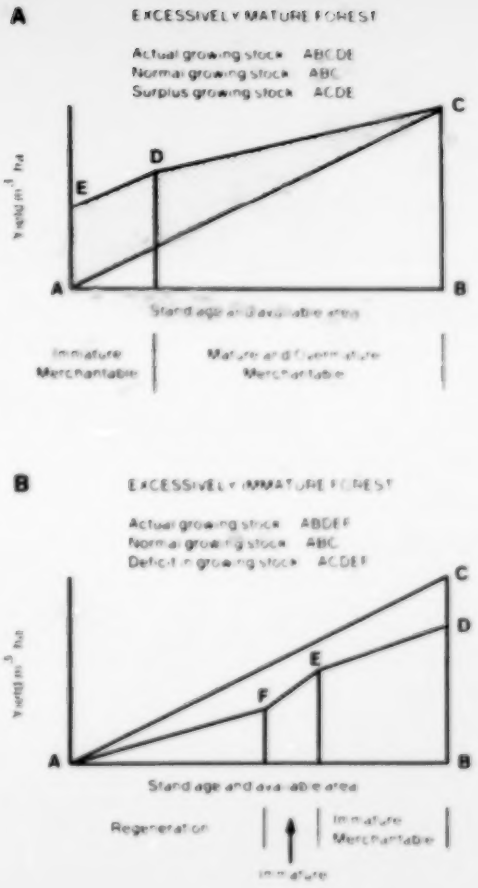

Fig. 3. Growing Stock Relationships For Normal and Unmanaged Forests.

sources other than cutting must be estimated and the cut must be adjusted accordingly. Because of the possibility of catastrophic losses from fire or insects, allowable cuts tend to be conservative.

Regeneration. The restocking of areas where the growing stock has been depleted by cutting, pests or fire is predominantly by natural regeneration. In some instances regeneration is delayed for a considerable number of years after disturbance and the lost opportunities can be significant. A 20-year delay in regenerating a species operated on an 80-year rotation is about equivalent to a 25% loss in harvestable yield. Thus, regeneration delays reduce the long-term levels of production far below that of the Normal Forest.

Management intensity

Levels of forest yield, growth and depletion are substantially increased or decreased from that in the natural forest by the magnitude of the silvicultural input and the control of depletion. **Extensive** and **intensive** are the terms used to describe the two levels of forest management commonly recognized.

Extensive management attempts to maintain a supply of merchantable timber and the existing productive base by ensuring that depleted areas are regenerated, providing partial protection against losses from fire insects and disease and setting guidelines for the quantity of timber to be harvested.

Intensive management increases both the productive base and the natural level of productivity by restocking old NSR lands, increasing the growth rate by using genetically superior tree species, increasing timber quality and value by silvicultural techniques such as cleaning, thinning, fertilization, improvement cuts and pruning in established stands. Additional protection measures also enhance the natural productivity of the land, particularly on the more productive and valuable areas.

Forestry in Canada is largely practiced at the extensive level of management intensity.

METHOD OF STUDY

Data

The data used in this report are available in published form (see References), and were provided by the provincial, territorial and federal government agencies having responsibility for the management of the forest resource. Some estimates were derived by the authors so that a more complete approximation of the change in the resource could be presented. When this was done the estimated figures were placed in square brackets to differentiate them from the published figures.

New information has also become available from many of the provinces and has been incorporated into the report. Those figures that have changed from the published reports listed in the References are noted on the appropriate tables and appendices.

Model

A simple model to assess change in the forest resource was used. Certain assumptions prevailed. First, Canada's forest inventory was accepted as presenting the overall statistical description of the resource as of December 1981; second, it was assumed that the inventory had accounted for changes in area and volume, as shown under accruals and depletions, that have taken place over the period 1977-1981; third, the discussion of results and implications for resource management is presented within the framework or concept of the Normal Forest.

The method developed to present the status of Canada's forest resource is essentially modelled on the common bank statement familiar to every Canadian that uses a savings or chequing account. The terminology is slightly different but is easy to grasp and understand.

Forest capital is the land base and the timber growing on it. Accruals are equivalent to deposits to forest capital and the interest on capital that occurs from forest growth. Depletions are equivalent to withdrawals from the available capital. The Accrual — Depletion Balance is the 5-year annual average for accruals and withdrawals over the reporting period.

Details concerning the data and computational methods associated with forest capital, accruals, and withdrawals are presented in Appendix 1.

CANADA'S FOREST CAPITAL

General relationships

Canada's forest capital is composed of two parts: the land base available for forest production plus the merchantable volume growing on it. Qualitative descriptions and definitions were provided

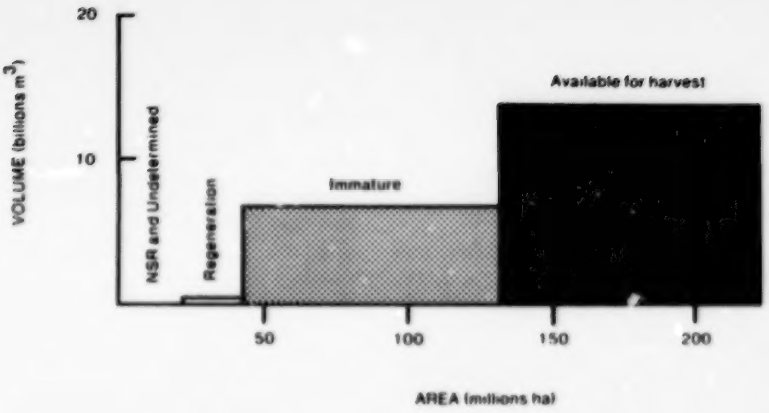

Fig. 4. Canada's Forest Area and Volume of Growing Stock by Maturity Classes.

in a previous chapter (pp 16-17) and statistical data on forest capital are given in Appendix 4, Tables 1.1 to 1.6. This chapter presents a quantitative summary of Canada's forest capital.

Forest land in Canada is divided between those lands available for timber production and those that are undetermined, reserved for other purposes, or are not suitable for growing and harvesting wood on a commercial basis (Table 1.1).

Alienated lands. Alienated lands may be capable of producing merchantable timber, but have been reserved for other purposes such as parks, reservoirs or military establishments. These lands comprise 7.9 million ha and represent about 3% of the total productive forest area.

Undetermined lands. There are 28.0 million ha of productive forest land for which there are no data available regarding their level of productivity. These unclassified lands are confined to Nova Scotia, Ontario and the Yukon Territory and comprise about 11% of the total productive forest areas as follows:

Nova Scotia: 0.9 million ha of land in Cape Breton Island have been heavily damaged by forest pests and data are not yet available.

Ontario: 9.8 million ha of land in southern Ontario are currently being inventoried but data are not yet available.

Yukon Territory: 17.3 million ha of land were not classified by the inventory. New data for the Territory will be available in 1986.

Noninventoried lands. The noninventoried lands are generally located in the northern parts of the provinces, distant from mills and manufacturing centers. They contain very little productive forest land and have extremely low yields. Their potential forestry contribution to Canada's economic well-being is marginal.

Forest land and volume capital

The land base utilized for timber production is defined as Productive Nonreserved Forest Land and it is comprised of 221 million ha. A major portion, 200.5 million ha, is in the provinces while the federal government administers 20.5 million ha of forest in Canada's two northern territories. Quebec and British Columbia have the largest areas devoted to timber production — 53.3 million ha and 50.8 million ha respectively — and Nova Scotia and Prince Edward Island have the least.

Of the 221 million ha of land devoted to forest production (Table 1.2) about 90% is stocked to commercial tree species and the volume of merchantable wood growing on this land is estimated

at 21.5 billion m^3. Softwoods and hardwoods comprise 81% and 19% respectively of the total. British Columbia contains about 45% of this volume and Quebec, Ontario and Alberta contain 20%, 15% and 7% respectively. The provinces account for about 20.7 billion m^3 and about 0.7 billion m^3 are growing in the territories.

The average yield per hectare which includes all maturity classes, ranges from a low of 32.4 m^3/ha in the Northwest Territories to a high of 204.6 m^3/ha in British Columbia. The average for Canada is 108.6 m^3/ha. Ten of the twelve provinces and territories have an average yield lower than the national average. When British Columbia is excluded, the average yield for the remaining provinces and territories is 78.7 m^3/ha.

The growing stock is made up of both natural forests and man-made forests. Reforestation activities in the provinces commenced about the turn of the century but these man-made forests only comprise about 1.4% of the stocked forest area. Ontario has the largest area of man-made forests, 1.2 million ha, and British Columbia is second with 0.78 million ha. All provinces have mounted major reforestation programs during past decades and these efforts are continuing.

Forest capital by maturity classes

Foresters strive to establish a distribution of forest areas comparable to that of the Normal Forest. On a national basis (Table 1.3):

- regeneration is about 20 million ha or 9%,
- immature – 91 million ha, or 41%,
- available for harvest – 87 million ha, or 39%
- NSR – 22 million ha, or 10%

The areas of greatest predominance are in the immature class and the class that is available for harvest. The regeneration forest is relatively small and about equivalent to those lands that did not restock to commercial tree species.

Regeneration forests. These are productive forest lands that have been renewed by natural seeding or by planting to commercial tree species. Approximately 20 million ha of land are classified as being in a state of regeneration.

In nine of the twelve provinces/territories, regeneration lands account for 8% or less of the forest area utilized for timber production. Whereas in Quebec, Saskatchewan, and the Yukon Territory, regeneration lands represent 13%, 22% and 29% respectively. This divergence from the general average for the nation can in part be accounted for by a history of fire in Saskatchewan and the Yukon Territory, and harvesting in Quebec. The age of the inventory data is also a factor to recognize as a major portion of the Saskatchewan information and all of the data from the Yukon is more than 20 years old.

Regeneration forests do not usually contain merchantable volume as the commercial tree species are generally less than one metre in height. The volumes shown in Table 1.3, Appendix 4, are attributed to noncommercial tree species that were left on the growing site after harvesting.

Immature forests. Those trees or stands that have grown past the regeneration stage, but may not contain sufficient merchantable wood to be harvested, are classified as immature forests. There are approximately 91 million ha of immature forests in Canada.

In Ontario, Manitoba and the Northwest Territories more than 60% of the forest land utilized for timber production is stocked to immature trees while in Newfoundland and Nova Scotia the amount is about 15% or less. The remaining seven provinces and the Yukon have between 30% and 49% of their forests classified as immature.

The average yield in cubic metres per hectare is generally in excess of the minimum merchantable limit of 30 m^3/ha, and in specific cases thinning operations can be conducted to utilize material of merchantable sizes. Ontario, where 63% of timber lands are immature, also conducts the largest partial-cut harvesting operation; some of the volume harvested on these operations comes from thinning operations on these immature forests.

Forests available for harvest. Forests that are mature, overmature, those that are uneven-aged and those forests having an undetermined age have been grouped and classified as available for harvest. These forests comprise 87 million ha and contain about 14 billion m^3 of merchantable

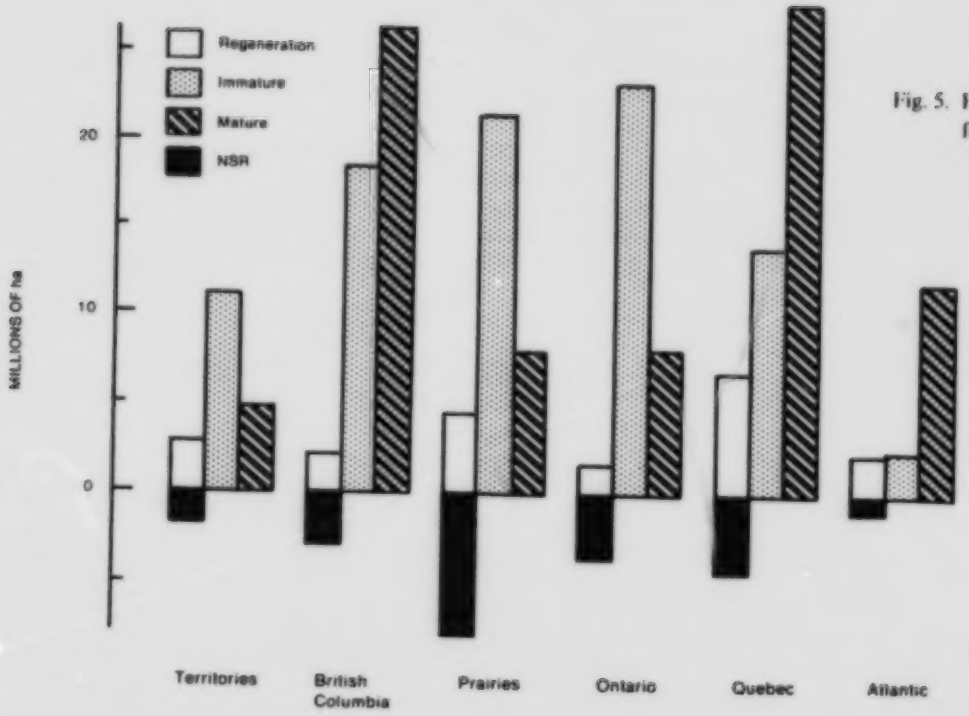

Fig. 5. Forest Land Available for Timber Production.

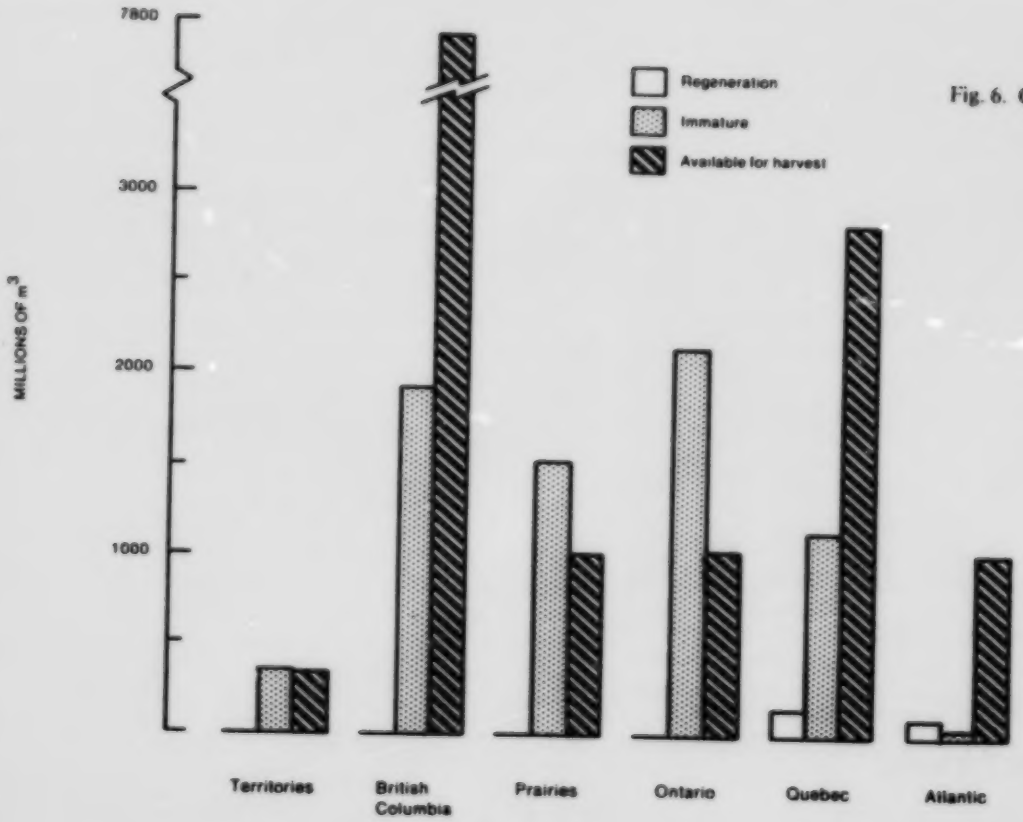

Fig. 6. Growing Stock Volume.

wood. More than half of this total (7.7 billion m^3) is in British Columbia with Quebec and Ontario containing 2.8 and 1.0 billion m^3 respectively. Each of the remaining provinces and territories contain less than 465 million m^3.

In the provinces of Prince Edward Island, New Brunswick, Quebec, Saskatchewan, British Columbia and the Northwest Territories the volume available for harvest comprises more than 50% of the total in each province or territory. Manitoba, Ontario, Alberta and the Yukon Territory have 41% or less of their merchantable volume available for harvest.

Forest capital in nonstocked forest land

This land class comprises about 22 million ha or 10% of Canada's productive nonreserved forest land (Tables 1.5 and 1.6). It does not support tree growth because of failures to restock to commercial tree species following harvest or destruction by fire and pests. These lands are generally covered with vegetation such as alder, willow, mountain maple, stripped maple or pin cherry and other shrubs which provide strong competition to the regeneration of commercial tree species. Only intensive silvicultural treatments will bring this land back to a productive state.

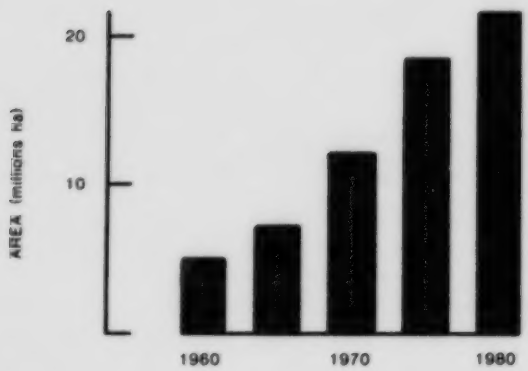

Fig. 7. Cumulative Area of Productive Forest Land that is Not Satisfactorily Restocked to Commercial Tree Species.

Up to 1960, about 5 million ha of productive forest land were classified as NSR. This amount has more than quadrupled in the last 20 years due to harvests, burns, pests and other causes. The cause or disturbance contributing the greatest area to NSR lands remains classified as Undetermined. This class is used to designate those areas of NSR where the cause or class of disturbance is not known or the records of the disturbance are not available. The Undetermined class comprises 52% of all NSR lands.

On a national basis, 77% of all NSR lands are in the provinces of Alberta (26%), Quebec (20%), Ontario (17%), and British Columbia (14%). These are also the provinces that contribute 73% of the productive forest land capital and 86% of the wood volume capital of Canada.

ACCRUALS TO FOREST CAPITAL

General relationships

Accruals or increases to Canada's forest capital occur from three sources. First, the standing timber of forest capital increases in volume as a result of natural growth processes. Second, a certain amount of land that is not stocked with commercial tree species is regenerated naturally each year. Third, the implementation of silvicultural practices such as the annual replanting of depleted areas and the treatment of established stands may result in a growth significantly greater than that obtained from natural forests. Details on the accruals to forest capital are shown in Appendix 4, Tables 2.1 to 2.8.

Accruals to stocked volume and area

Canada's forests annually increase by about 338 million m^3 of merchantable volume. The standing forest contributes 335 million m^3 and natural regeneration is responsible for an additional 3 million m^3. At present, about 130 000 m^3 of growth is attributable to silvicultural practices such as planting, spacing, fertilization and stand tending. These accruals to merchantable volume are 78% in softwoods and 22% in hardwood tree species (Table 2.1).

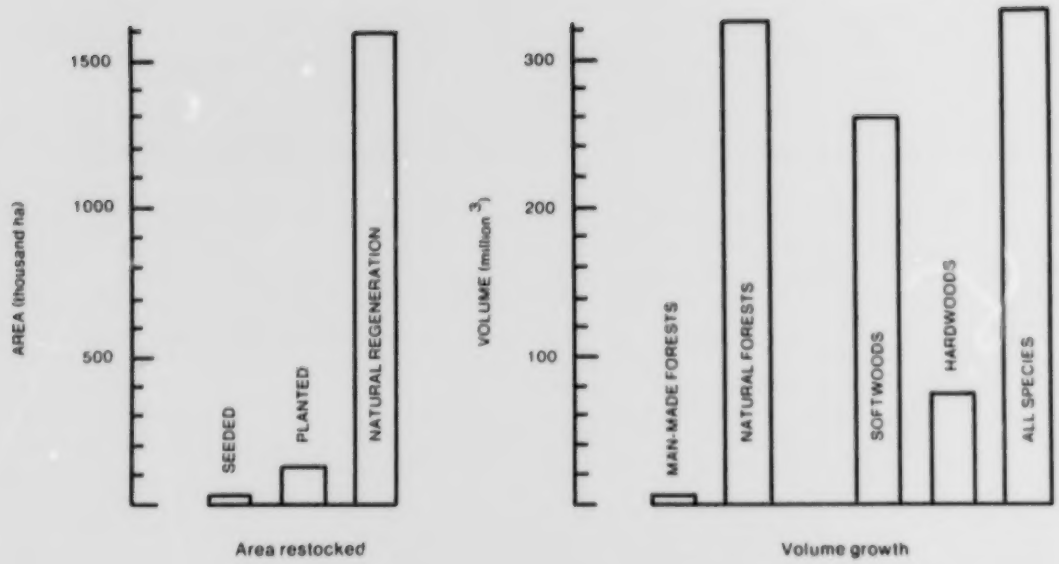

Fig. 8. Average Annual Accruals to Forest Capital.

Only the forests of British Columbia, Quebec and Ontario grow more than 50 million m³ annually, and these three provinces account for more than 73% of all volume growth in the nation.

The growing stock capital of forest land and the standing timber on it contributes 99% of the annual volume growth. Canada's current growing stock is predominantly the natural forest. It receives extensive forest management essentially in the form of fire protection but the rates of growth are low, averaging about 1.7 m³/ha/a. The mean annual increment in British Columbia and Nova Scotia is 2.3 m³/ha/a but in the remainder of Canada it averages to about 1.5 m³/ha/a.

Silvicultural practices. The average annual area of timber land receiving silvicultural treatments in Canada is approximately 233 000 ha. The areas that were planted and seeded total 166 000 ha and the remaining 67 000 ha of standing forest were thinned, pruned and fertilized (Tables 2.2 and 2.3).

Tree planting is carried out in every province of Canada but the seeding of harvested or burned lands is only carried out in those provinces east of the Rocky Mountains. The provinces having the largest forest areas and harvesting the largest volumes of wood, British Columbia, Ontario and Quebec, also conduct the largest forest renewal programs. The areas planted and seeded in these three provinces comprise more than 80% of the land area that is regenerated artificially in all provinces and territories. The federal government, which administers the forest lands in the Yukon and Northwest Territories, has no program of artificial regeneration.

Fertilization, thinning and pruning of stocked productive forest lands is carried out in all provinces. The greatest effort in fertilization took place in British Columbia where approximately 4 500 ha were completed annually. The total for Ontario and Newfoundland is less than 650 ha annually. Ontario and British Columbia thinned about 19 000 and 11 000 ha respectively and both provinces also conducted some operations in stand cleaning and weeding.

Natural regeneration. Lands that have been depleted by cutting or wildfire, if left untended, may eventually regenerate to a cover of forest vegetation and in Canada much of the restocking of forested lands is attributed to natural processes. Tree seeds left in logging slash or car-

ried by wind, animals and birds eventually germinate and grow on these harvested and damaged lands. Unfortunately no published statistics or data are available on the rate of restocking that takes place. Estimates provided by the provincial and territorial forest agencies vary markedly.

On cut-over lands, natural regeneration (Table 2.4) occurs at a rate of about 400 000 ha annually. This includes lands that have been clearcut as well as those lands receiving other harvesting treatments. For those lands receiving partial harvesting treatments and those that are scarified, the authors have assumed that regeneration is 100% successful. On clearcut lands the success of natural regeneration is much lower and for Canada as a whole, it approximates 30%.

Of all the timber lands harvested in Canada, more than 60% occur in the boreal forests. Clear felling operations remove the merchantable stem wood and leave an accumulation of logging slash composed of unmerchantable tops, branches, leaves and stumps. In addition, the removal of the forest canopy also affects the water table causing increased runoff and environmental conditions that are not particularly conducive to the establishment of natural regeneration. These are only a few of the factors that adversely affect the regeneration of cutover areas.

Lands available for timber production that have been recently burned appear to regenerate at a much higher rate and at least 70% of all areas burned are assumed to be stocked with commercial tree species within 10 years. Lands that receive repeated burns may have their nutrients depleted, the forest cover eliminated and may remain unstocked for many years. No estimates of regeneration rates for these lands are available.

No official figures are available regarding the rate of natural regeneration on pest damaged lands and old NSR lands. Estimates of 80% and 1% respectively have been used to cover these situations.

The annual average amount of land accruing to a stocked condition is 1.77 million ha and natural regeneration makes up 90% of this total.

WITHDRAWALS OF FOREST CAPITAL

General relationships

Planned harvests are fundamental to good forest management. There is no loss of productive area when the cutovers are restocked immediately, however, forest capital can be reduced by neglect, regeneration failure and by the unpredictable but continuing depletion of area and volume that is caused by fire and forest pests.

The control and management of forest depletion provides the basic mechanism for restructuring existing growing stocks of timber so that long term sustained harvests and optimum growth are in balance and the growing stock area and volume remains constant. Both objectives are largely attained if the distribution of age classes from regeneration to maturity is approximately equal and if productive forest land is restocked following depletion. The annual allowable cut and the extent to which losses from fire, insect and disease can be minimized are the practical means of bringing management units closer to sustained yield and the conceptual ideal of the Normal Forest.

Statistics on withdrawals and depletion are presented in Appendix 4, Tables 3.1 to 3.9.

Harvest The average volume of timber harvested annually during the period 1975-1979 for all of Canada was 143 million m^3 of which 92% was made up of softwood species. For all species this amounted to 0.7% of the 1981 growing stock, but for hardwoods only 0.05% of the growing stock (Table 3.1).

On a provincial basis British Columbia accounts for about one-half of the volume harvest, and Ontario and Quebec combined produce one-third. The approximate area cutover was about 759 000 ha or 0.4% of the stocked productive forest land available for timber production.

Canada's annual allowable cut for 1979 (Table 3.1.1) was estimated at 227 million m^3 (Environment Canada 1981). The average annual harvest 1975-1979 of approximately 143 million m^3 is about 63% of capacity. Surpluses in

excess of 18 million m^3 annually occur in Quebec, Ontario and Alberta whereas only small annual surpluses of less than 7 million m^3 occur in the remaining provinces.

The average annual harvest for the period under study is 43% of the sustainable mean annual increment at rotation age.

Fire losses. In interpreting forest fire statistics (Table 3.2), two facts should be kept in mind: fire losses are highly dependent upon weather patterns which for any given year, or even five-year periods may vary widely between provinces; and, within the same time frame, fire losses may be quite variable within a province. Secondly the derived volume statistics assume that all of the volume on the burned-over areas has been killed or destroyed. This is not always the case since some fires result in little volume loss.

The average annual area of all land burned over in Canada during the 1977-1981 reporting period was 2.7 million ha of which 1 million ha was stocked productive forest land. The volumes destroyed are estimated to be about 81 million m^3 or about 56% of the volume harvested.

In relation to the 1981 inventory the annual losses were 0.4% of the total growing stock volume. The productive area burned was about 1/3 larger than the area cut-over.

During the five-year reporting period, the average annual losses were extremely high in Saskatchewan and Alberta, high in Manitoba and Ontario, but were relatively low elsewhere. Volume losses in Alberta and Saskatchewan accounted for 66% of the national total.

Depletion from forest pests In early forest management, protection from fire was paramount, especially in the settlement areas. Concern for losses from forest pests was almost negligible because huge surpluses of mature and overmature timber were available for harvest. In addition, there was a limited understanding of the life cycles of forest pests and the technology of pest control was largely confined to the agricultural sector. But as local timber shortages began to occur, particularly in eastern Canada, concern for these losses escalated. Logging activities were often rescheduled to ensure that existing yields were harvested and control measures such as aerial spraying, pheromone traps, insect parasites, sanitation cutting and trap tree operations were introduced to limit the populations of forest pests and minimize the resulting damage and mortality.

Brace and Golec (1982) reported on pest control activities in six provinces. British Columbia concentrated on mistletoe control, and Ontario, Quebec, New Brunswick, Nova Scotia and Newfoundland concentrated on spruce budworm control. In terms of areas annually treated, New Brunswick (2.3 million ha), and Quebec (1.9 million ha) are the provincial leaders. Nationally, an average of 4.2 million ha were treated annually.

Only the average annual losses due to mortality attributable to insects and diseases are reported and discussed in this report. Growth losses and those losses attributable to decay are not included in these data (Tables 3.3, 3.4 and 3.5).

The average annual mortality from insects and disease for the period 1977-81 estimated to be about 72 million m^3 with almost 80% of it occurring in coniferous species. The equivalent area losses are estimated to be 595 000 ha.

The insect pests destroy about 44 million m^3 of merchantable timber volume annually. The spruce budworm kills about 35 million m^3 annually and about 9 million m^3 is lost to bark beetles and miscellaneous defoliators. Almost all of these losses occur in the economically valuable softwood species.

Mortality from diseases is somewhat less than from the insect pests, but these losses are still about 27 million m^3 annually on a national basis. Hypoxylon canker kills about 11 million m^3 of aspen annually and a variety of stem and root decays is responsible for losses of about 12 million m^3 per year. These losses are in both softwood and hardwood tree species with the softwood losses making up about 44% of the total.

Total depletion from all sources

Productive area. The total depletion on a national basis of stocked productive nonreserved forest land (Table 3.6) is estimated to be about 2.2 million ha, equivalent to an annual rate of 1.1% of all the land available for forest produc-

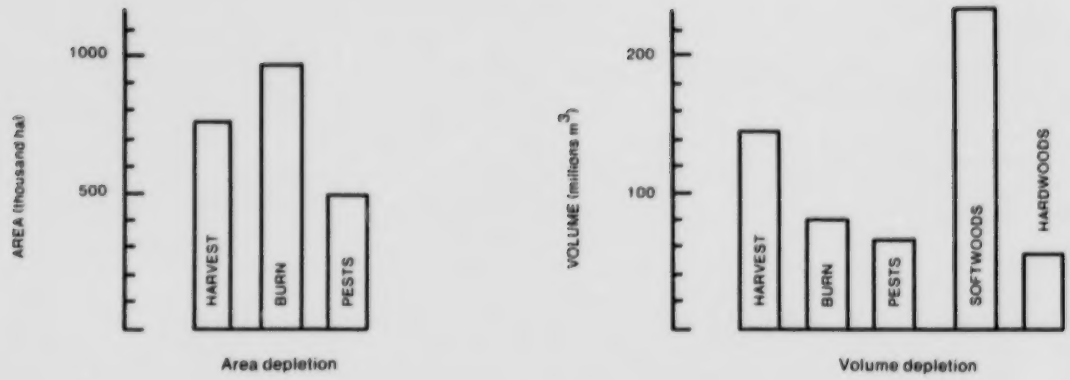

Fig. 9. Average Annual Depletion of Forest Capital.

tion. The main causes of depletion were fire, harvesting, and insects and diseases, which accounted for 43%, 34% and 23% of the depletion, respectively.

The relative rate of area depletion by fire, harvest and pests varies greatly by provinces. During the five-year period the major fire losses were in the three prairie provinces and Ontario, and amounted to 848 000 ha of productive forest land. Insect and disease losses were most significant in Ontario and Quebec where the timber production lands were depleted by about 389 000 ha (area equivalents) annually. In 8 out of 12 provinces and territories, the area depleted by fire and forest pests exceeds the area depleted by harvest.

Growing stock volume. Nationally, depletion to the merchantable volume of the 1981 growing stock (Table 3.7) averaged 287 million m^3 annually or 1.3% of the growing stock for all species combined. For softwood species only, the depletion was 233 million m^3 and for hardwoods the depletion was 55 million m^3. The depletion of the hardwoods was relatively high because the most severe fire losses during the reporting period occurred in Ontario, Manitoba, Saskatchewan, and Alberta, which have the highest proportion of hardwood species — mainly poplar and birch.

Overall, harvesting accounted for 50% of the volume depletion, fire for 28%, insects and disease 22%. Relative to the 1981 Inventory, harvesting depletes the volume of the growing stock at a much higher rate than it does the area, since cutting operations are mostly in mature and overmature stands with high volumes per hectare.

In most provinces the relative total depletion of softwoods was between 1.0 and 2.0% of the growing stock with the components of depletion varying widely. In Nova Scotia and Saskatchewan, the rate of depletion for softwoods was substantially higher (3.2 and 3.1% annually), and the principal component of depletion was different in each of these provinces.

BALANCE OF ACCRUALS AND WITHDRAWALS

A comparison of accruals and withdrawals in area and volume provides a means for assessing the changes in the forest resource since the previous national forest inventory consolidation in 1976 (Bowen 1978). It reflects long-term growth trends, and the periodic silvicultural activities and withdrawals due to harvests, fire, and pests. The results show the level of forestry activity, the provinces or territories in which they occur, and the cause of deviation from the balanced state. They are presented in Appendix 4, Tables 4.1 to 4.5.

Land capital

The annual withdrawal of land capital from forest production (Table 4.1) exceeded those areas that were planted and regenerated naturally. For all of

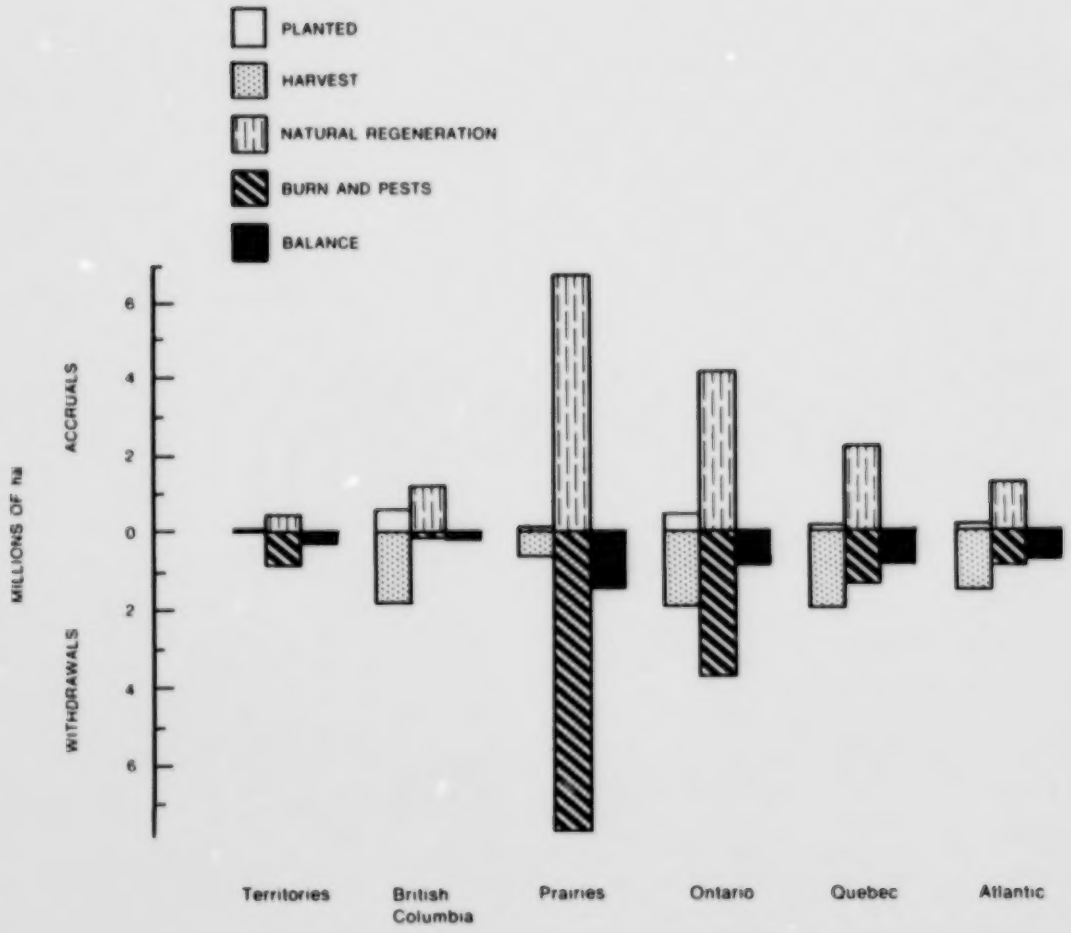

Fig. 10. Average Annual Accruals, Withdrawals and Balance of Land Capital 1977-1981.

Canada the excess of withdrawals over accruals to the stocked or forested landbase is about 452 000 ha annually. This area of NSR is about equivalent to the land area of Prince Edward Island.

In Ontario and Quebec, forest renewal programs brought about 74 000 ha of forest land back into production and natural regeneration contributed 635 000 ha. But these efforts were in contrast to the areas withdrawn from production which totaled 884 000 ha. About 386 000 ha were harvested and about 498 000 ha were lost to fire and pests. There was a combined deficit of about 175 000 ha or about 38% of the national total in these two provinces.

Heavy losses were also experienced in Manitoba, Saskatchewan and Alberta, largely due to extensive areas of forest land that were burned during the five-year period. The losses from forest production in these three provinces was about 32% of the annual total.

The annual harvest on forest lands is a planned utilization of the mature yield, and the area involved amounts to 759 000 ha or 34% of the annual area depletion. Planned accruals to capital from regeneration and silvicultural activities, however, only account for 573 000 ha. Thus

even for those forestry activities for which there are approved management plans there is an annual deficit; 186 000 ha of productive forest land is taken out of production annually. The planting and silvicultural activities in combination with natural regeneration are not even sufficient to restock the lands that are harvested and the incidence of fire and forest pests only compounds the problem.

Those lands that are depleted annually from harvest, burns, and pests total 2.215 million ha. On an annual basis about 8% of this total is planted, 72% regenerates naturally and 20% goes out of production as NSR land. At present about 22 million ha of productive forest land is not stocked to commercial tree species. If present levels of management persist and accruals to and withdrawals from the land base continue at present levels, by the year 2000 the amount of NSR land could total about 31 million ha. This means that about 14% of the forest land base could be idle and out of production.

Volume capital

Annual accruals to the 1981 growing stock capital (Table 4.2) for all of Canada totalled 338 million m^3. Almost all accruals to capital are from the growth of existing forests; only 1% comes from annual silvicultural activities and natural regeneration. Annual withdrawals of volume total 287 million m^3 and includes 144 million m^3 from harvesting operations and about 143 million m^3 from fire, insect and disease losses. Salvage operations recovered about 6% of the volume losses and are included in the harvested total. For Canada as a whole the excess of accruals over withdrawals from volume capital amounted to 51 million m^3.

Quebec and British Columbia which experienced relatively low fire damage show the largest accrual balance with the remaining provinces showing relatively modest amounts. Four provinces, Nova Scotia, Ontario, Saskatchewan and Alberta show negative volume balances due to the high amounts of timber either burned or destroyed by pests. These over-all balances differ by species groups.

Softwoods. The national situation (Table 4.3) shows an annual accumulation of 30 million m^3 of softwoods but five provinces are in a deficit position. In Nova Scotia the annual harvest exceeded the growth from all sources and this is compounded by losses from fire and pests that are almost as large as the harvest. In New Brunswick the depletion due to harvest and fire was smaller than the overall growth but pest losses put the province in a negative balance position. Ontario's deficit position for softwoods is attributable to high losses from fire as well as forest pests. These pest losses appear significantly large in comparison to those recorded for the province of Quebec and may be due to differing methodologies used by the Canadian Forestry Service in these two provinces. For example; stocked volume capital of Quebec is about 1 billion m^3 larger than that of Ontario and one would expect increased losses from pests in Quebec given that the proportion of timber available for harvest is about 68% whereas in Ontario it is only 31%. In both Saskatchewan and Alberta the harvest volume was less than the forest growth, but high annual losses to fire put the softwood volume balance in a negative position.

Only Quebec and British Columbia show positive volume balances in excess of 15 million m^3. All other provinces are within a relatively narrow range of an equal balance position.

Hardwoods. The positive balance overall for the hardwood volume capital was 19 million m^3. Only the provinces of Saskatchewan and Alberta showed a deficit position; in both provinces, large losses were due to fire, however the pest losses also exceed volumes withdrawn by harvesting (Table 4.4).

The greatest accruals to hardwood volume occurred in Quebec and amounted to 13 million m^3. It should be noted that pest losses were rather small; one tenth of those recorded in Ontario. Once again these major differences may be attributable to survey methodology.

Resource statements of capital and annual change

The average annual changes in the volume of forest capital between 1977 and 1981 are summarized in Table A, and those for area in Table B. The data of Appendix 4 are presented in the format of a resource statement showing the capi-

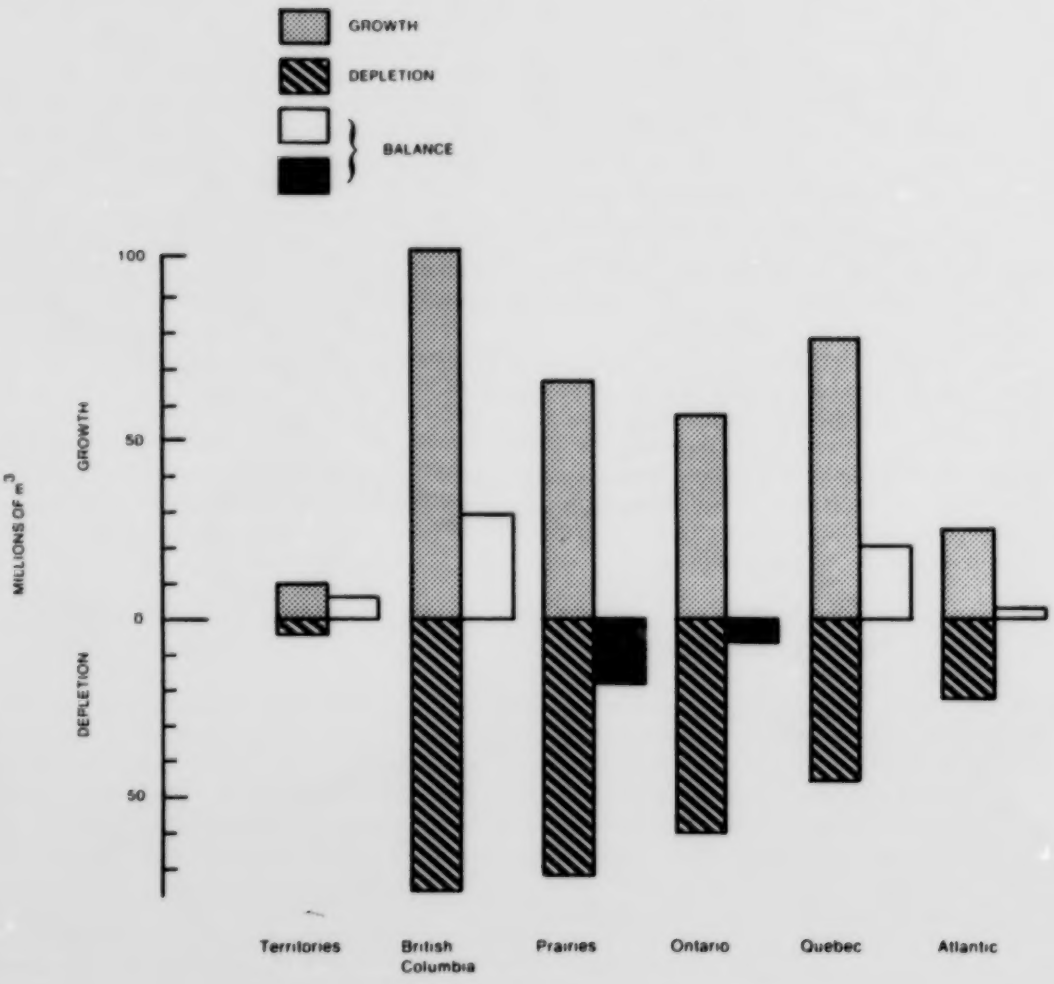

Fig. 11. Average Annual Growth, Depletion and Balance of Growing Stock Volume. 1977-1981.

tal amounts as well as the accruals and withdrawals.

An important item for which there are no data currently available concerns the planned withdrawal of lands available for timber production and their reallocation to other purposes. This problem is currently under study by several professional forestry organizations but no figures have yet been released. The situation in British Columbia gives an indication of the serious implications for forestry. In a detailed analysis of the forest resource (Ministry of Forests 1980), the provincial government projects that by the year 2000, 25% of the Crown's land base available for timber production will be withdrawn and devoted to other purposes. Recognizing that British Columbia contains about 55% of Canada's mature timber volume, the implementation of this policy will have a major impact on the forest industry's ability to make a continuing and significant contribution to the economy of the nation.

CONSTRAINTS, IMPLICATIONS AND POLICY OPTIONS

This chapter is a general synthesis of the detailed statistics previously presented. It sketches the current to short-term implications of these new data, and suggests their probable impact on the long-term sustained production of harvestable timber.

The validity of the conclusions that can be drawn are sometimes limited by the nature of available statistics and by factors not quantified in this study. General limitations of the statistics that must be kept in mind when evaluating them are indicated below. Other cautions specific to particular situations are mentioned elsewhere.

Data constraints

Of the 1981 estimates of forest capital used in this report 55% of the data were less than 10 years old, 35% were 10 to 20 years old and the remaining 10% were more than 20 years old. Few of these data have been adjusted for subsequent changes resulting from aging, growth, and depletion from logging, fire, insects and disease. Therefore some components, particularly maturity distributions, may have an unknown bias.

Both the 1981 forest capital estimates and the growth and depletion data are measured in terms of gross merchantable volume and area, i.e., the physical supply which may be substantially more than the economic supply. The economic supply depends upon such factors as accessibility, product suitability including tree species, quality and size, and market demand. On a national basis, reliable data on the economic supply are not available although several studies of it are in progress. Confusion between the economic and physical supply of timber explains many of the misunderstandings that are common to forestry problems.

The third general limitation is common to many statistical presentations but because of its importance in forest management it bears reiteration. Namely, the level of integration for data presentation determines its use and the conclusions that can be drawn from it. Most of the statistics presented are derived from the detailed classifications required at the level of the forest management unit. To obtain the national, provincial and territorial summaries, the original data had to be standardized, merged and generalized; and, this process tends to reduce the final data to the level of the lowest common denominator. Thus, reliable detailed information from one area may sometimes be merged with highly subjective estimates from another. Also, the wide variation within provinces is marked although it is reflected to some degree in the deviations of the provincial averages about the national averages. For broad policy and planning purposes this data characteristic is rarely significant, but the data cannot be extrapolated to the detailed operational planning level required for program implementation.

Implications for growing stock capital

The mature and overmature timber in existing forests is the physical supply upon which forest industries are completely dependent for their economic survival. There must be sufficient mature timber to maintain a supply to the mills until such time as currently immature stands reach maturity.

Despite relatively uncontrolled depletion until recent years, the supply of timber available for harvest is still substantial — a volume of 14 billion m^3 on an area of 87 million ha, which at the current rate of depletion (volume 287 million m^3 and area 2.2 million ha) would last for 40 to 50 years.

Nationally, the amount of mature and overmature timber is significantly greater than that required to sustain continuous production from areas having a more normal distribution of age classes. It appears to be adequate in most provinces to bridge possible gaps that may occur between its orderly liquidation and the maturing of new supplies — even if discounted by about 1/3 as a crude approximation to the economic supply.

The area of immature stands (91 million ha) from which the next supply will come is slightly less than that of the mature class. Within provinces, low proportions of immature stands

TABLE A

CANADA'S VOLUME OF FOREST GROWING STOCK CONSOLIDATED STATEMENT OF CAPITAL AND ANNUAL CHANGE 1977-1981

		Millions m^3
Growing Stock Capital 1981:		
Regeneration		288.21
Immature		7 181.44
Available for Harvest		14 066.66
TOTAL GROWING STOCK		21 536.31
Annual Accruals to Growing Stock Volume:		
Stocked Forest		334.80
Natural Regeneration		2.74
Artificial Regeneration		0.32
Silvicultural Treatment		0.12
TOTAL ANNUAL ACCRUALS		337.98
Annual Withdrawals from Growing Stock Volume:		
Planned Operations		
Harvest	(143.68)	
Land Alienation	(No Data)	
Total		(143.68)
Depletion		
Fire	(79.98)	
Pests	(63.81)	
Total		(143.79)
TOTAL ANNUAL WITHDRAWALS		(287.47)
Annual Average Balance		
Net Increase (Decrease) in Growing Stock		50.51

TABLE B

CANADA'S AREA OF PRODUCTIVE FOREST LAND CONSOLIDATED STATEMENT OF CAPITAL AND ANNUAL CHANGE 1977-1981

		Millions ha
Land Capital 1981:		
Not determined		0.76
Not Satisfactorily Restocked		21.91
Stocked land		
Regeneration	20.14	
Immature	91.08	
Available for Harvest	87.14	
Total		198.36
TOTAL PRODUCTIVE LAND		221.03
Annual Accruals to Stocked Land:		
Natural Regeneration		
Cutovers	0.407	
Burns	0.669	
Pest-Killed	0.400	
Old NSR	0.122	
Total		1.60
Artificial Regeneration		
Planting	0.129	
Seeding	0.037	
Total		0.17
TOTAL ANNUAL ACCRUALS		1.77
Annual Withdrawals from Stocked Land:		
Planned Operations		
Harvest	(0.759)	
Land Alienation	(No Data)	
Total		(0.76)
Depletion		
Fire	(0.956)	
Pests	(0.501)	
Total		(1.46)
TOTAL ANNUAL WITHDRAWALS		(2.22)
Annual Average Balance:		
Net Increase (Decrease) in Stocked Land		(0.45)

tend to be offset by higher representations of mature stands. This provides a high degree of flexibility in modifying future supplies by controlling the rate at which mature stands are liquidated and by the level of silvicultural input used to improve the yield of immature growing stock.

The area of land in the regeneration stage is 20 million ha and NSR lands comprise 22 million ha due to regeneration failures following depletion. These are the lands that will grow the forests for future generations to harvest and in assessing the impact of current management decisions on the forest land base, a major concern is the rapid and continuing increase in these NSR lands. In 1960 about 5 million ha of productive nonreserved forest land were classified as NSR but by 1980 these NSR lands had increased to approximately 22 million ha. This transfer of land from a stocked productive status to a condition that is not satisfactorily restocked continues at a significant rate even though planting activities and silvicultural treatments are undertaken in all provinces. Unfortunately the area of all planted, seeded and naturally regenerated lands is less than the area of land depleted from harvest, fire and forest pests and the result is a depletion of forest capital at a rate of 452 000 ha/a. This continuing erosion of the land base will impact severely on the future options for forest management in Canada.

Changes in the volume of growing stock result from positive or negative growth-depletion balances. A positive balance due to forest growth or planting activities increases the growing stock, and a negative balance from depletion and harvest reduces the volume. The small national annual change in growing stock volumes (51 million m^3) suggests that the present imbalance in the age-class distribution of the growing stock is being perpetuated. Stated differently, a higher level of harvest (or total depletion) for a specific period of time could in some cases reduce the rather high reserve of mature timber without seriously jeopardizing future harvests assuming that most of the physical supply reported is economically accessible. The problem is to ensure that there are no major time gaps between the liquidation of older growing stock and the maturing of the younger stands. However, the magnitude of growing stock reserves that will be carried over into the future depends upon so many factors, technical, economic, social and political, that it is largely a discretionary value judgement.

Conservative management tends to hold substantial reserves as a hedge against catastrophic losses from fire and forest pests. More speculative management, following a "use it before you lose it" approach, liquidates surplus forest capital for various uses when market conditions are opportune, and maintains a minimum reserve of working capital. These judgements are reflected in the allowable cut set at the management unit level and are beyond the scope of this study. Available information does suggest, however, that most AACs are based upon quite conservative assumptions and are generally well below the total sustainable depletion. Actual cuts seem to be below the allowable cuts, but information on total depletion other than that in this study are not available. For several reasons, sustained harvest may not always be a realistic goal for all management units. From a technical standpoint, this may result from such severe imbalances in age-class distribution that the unit is not viable in itself and must be combined with other units. Similarly, there are often compelling economic, social or political reasons for liquidating all available merchantable timber to prolong the life of existing mills or communities. In situations such as this there is no loss of growth or reductions of future harvests **so long as the areas are regenerated after depletion.**

Silviculture

Silviculture involves both forest renewal and forest improvement operations. Renewal to maintain the productive base after depletion is the first priority and improvement of the existing land base and the forests on it is the second. They complement each other and should be undertaken simultaneously with relative emphasis governed by local conditions.

Forest renewal operations govern the availability and characteristics of the long term timber supply. They include: establishment of seed orchards, planting genetically superior tree stock, seed-bed preparation prior to artificial or natural seeding, and the modification of harvesting systems to ensure regeneration following depletion.

Forest improvement operations to increase the natural productivity and final yields are usually undertaken in established stands and take several forms. Cleaning in stands still in the regeneration phase improves spacing and removes trees of inferior quality and species. Thinnings and improvement cuttings in semi-merchantable immature stands provide better final yields of the more valuable species and products, and sometimes also recover the yields of trees that would be otherwise lost to natural mortality.

Cutting operations in immature and partially merchantable stands will become an increasingly important source of supply when the demand for low-quality material, such as that suitable for biomass, improves. These and other selective operations such as pruning and fertilization have a much greater impact upon timber quality and value than upon the total production of wood fibre.

The present efforts in silviculture are well below that required to maintain the land and timber supplies at the 1981 levels. About 20% of the areas now being harvested, burned or devastated by pests go out of production each year. In addition there is an accumulated backlog of land that has failed to regenerate in the past and totals about 22 million ha or 10% of all productive lands in Canada that are devoted to forestry.

At present the area of stand improvement operation is quite small, about 67 000 ha annually, although it has increased greatly in recent years. Investments in stand improvement have a short pay-off period and have immediate application in areas where mature timber is in short supply. Despite problems in quantifying the overall impact of forest improvement operations, it seems evident that major increases in such areas would be advantageous.

Policy options

There are at least three options available to Canadians for the future management of their forest lands:

1. Continue the present level of forestry activities and accept an additional loss of 9 million ha in the stocked land base by the year 2000.
2. Sufficiently increase the forest renewal and silvicultural activities to maintain the productive forest land base at its present level.
3. Greatly expand forest renewal to also reforest, in crash programs, the backlog of NSR lands and so achieve an early increase in final yields and annual growth of at least 10%.

A detailed analysis is beyond the scope of this study however the anticipated results of the policy alternatives identified, is worth a brief comment. For purposes of illustration, Figure 12 is included to depict the gains or losses that these policies will effect.

Canada is a nation that depends on its forests for its economic health and if growth and depletion of the forest resource are maintained at 1981 levels and forest land continues to go out of production at current rates, future harvests could be reduced 20 to 30%. This is the expected result of Option 1; the lowest level of input shown. This policy option poses a simple question: how long can Canada remain in the forestry business if it continues to reduce its forest land capital at present rates?

If the stocked productive land base can be stabilized near its 1981 area and level of productivity, an expansion of silvicultural activities would result in no further erosion of the land base. This is level 2 in Figure 12. Option 2 would seem to be a most realistic target for the year 2000.

To bring the backlog of NSR lands into production (Option 3) requires a major expansion of silvicultural activities. When restocked they would increase total production by more than the 10% their area would suggest because of the higher growth and final yields in man-made forests. This gain is between levels 3 and 5 in Figure 12.

To achieve the greatest return for any level of forest renewal there are obviously advantages in restricting the initial silvicultural effort mainly to the more accessible areas having an average or better level of site-quality, and in using the best quality seed sources available.

Silvicultural operations have two major constraints, one economic and the other technical.

The most important economic constraint is the

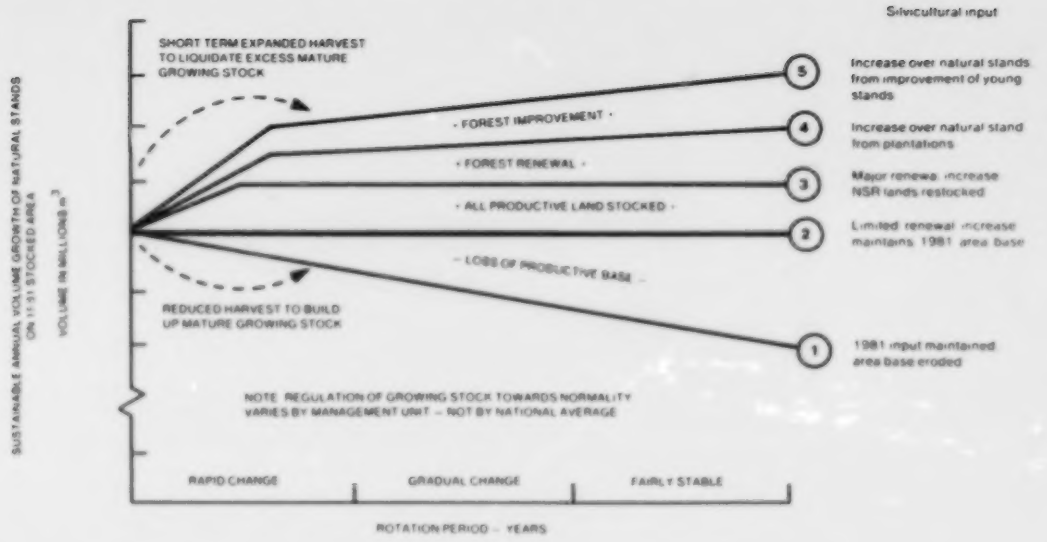
Silvicultural input
SHORT TERM EXPANDED HARVEST TO LIQUIDATE EXCESS MATURE GROWING STOCK
- FOREST IMPROVEMENT -
- FOREST RENEWAL -
- ALL PRODUCTIVE LAND STOCKED -
- LOSS OF PRODUCTIVE BASE -
REDUCED HARVEST TO BUILD UP MATURE GROWING STOCK
5
4
3
2
1
Increase over natural stands from improvement of young stands
Increase over natural stand from plantations
Major renewal increase NSR lands restocked
Limited renewal increase maintains 1981 area base
1981 input maintained area base eroded
NOTE REGULATION OF GROWING STOCK TOWARDS NORMALITY VARIES BY MANAGEMENT UNIT – NOT BY NATIONAL AVERAGE
RAPID CHANGE
GRADUAL CHANGE
FAIRLY STABLE
ROTATION PERIOD – YEARS
SUSTAINABLE ANNUAL VOLUME GROWTH OF NATURAL STANDS ON 1951 STOCKED AREA
VOLUME IN MILLIONS m³

Fig. 12. Sustainable Levels of Annual Volume Depletion For Different Management Intensities.

funding, usually governmental, required to keep the forest resource at even its present level. The pay-off for reforestation expenditures is well into the future because it takes at least 80 years to grow the majority of forests to maturity. In competing for a share of the total funding available, there is a natural tendency to favor those activities with short-term goals and pay-offs. Also involved is a long-standing debate as to whether expenditures are capital costs or operating costs, a question that in some respects resembles that reputedly posed by ancient theologians concerning the physical characteristics of angels. Fortunately the operating cost concept seems to be emerging as the winner. Thus, the concept of maintaining inherited (forest) capital for the common good appears to be gaining acceptance in principle if not always in funding.

Several technical constraints also influence forest renewal activities. First, there is no common standard as to what constitutes "satisfactory stocking" both qualitatively and quantitatively. Does a well stocked stand of aspen regeneration making excellent growth constitute satisfactory stocking if there are no existing markets in the area for aspen, and a very good stand of white spruce occupied the same site prior to harvest? If there are 500 trees per hectare at maturity, would the same number of seedlings 5 cm tall present on the same area five years after it was harvested constitute satisfactory stocking? National standards for stocking do not exist and the limited regeneration survey data available is difficult to integrate into reliable averages at the provincial and national level. A comprehensive summary of the real status of regeneration in Canada is lacking. The last evaluation to common standards for most of Canada , made by the Canadian Forestry Service over 30 years ago, (Candy 1951), is now largely obsolete because of the rapid change in logging methods — from horses to wheeled skidders and on-site processing equipment. However, despite the lack of an adequate data base for program evaluation and planning there seems to be no doubt about the seriousness of the present and future regeneration problem.

The second constraint is the technology and logistics involved in developing expanded programs of forest renewal. To develop and organize the facilities requires reasonable assurance that the programs will be expanded to an appropriate operating level at which it can be maintained or expanded if necessary. Expanded seed collection

and processing, nursery production, site preparation, seeding and planting equipment, and competent manpower to handle the programs take much time and money to develop and cannot be maintained if the funding is erratic and from special short-term economic make-work recovery programs.

SUMMARY AND CONCLUSIONS

The conclusions that emerge from this study support neither a doomful prediction of imminent disaster in the nation's forests, nor a highly optimistic forecast of how many times the future harvest might be increased by intensive forest management. Some of the 1981 images are sharp and clear with the physical features, both good and bad, readily seen and measurable; but in others the focus is so poor that only the general shape of the subject can be identified. In a few instances the images are blank. Despite imperfections, the composite mosaic is adequate to portray the main physical characteristics of the resource together with the general direction and rate at which it is changing at the national and provincial levels.

The physical volume of timber available for harvesting (mature and overmature stands) at the present rate of depletion (from all sources harvest plus fire and forest pest losses) is sufficient nationally to last for at least 40 years with a range of **20** and **80** years between provinces; variation between forest management units will be much greater. Thus there are wide regional disparities in timber supply as in other facets of the economy. Despite distribution problems, there is no question, that overall, the proportion of timber available for harvesting is much greater than that in forests with approximately normal age-class distributions. This would suggest that the current volume harvested could be temporarily increased where economic supplies are available in order to bring age-class distributions and the mature growing stock volumes closer to normality. For example, forest management units with surplus mature growing stock, which are in the majority if the inventory reports are correct, could have harvests greater than that which they could sustain indefinitely after a reasonable approximation of normality is achieved. The converse applies in those units with deficits. These purely fortuitous growing stock surpluses if used wisely provide the forest capital, or bridge-funding required for an orderly transition from largely unmanaged forests to managed forests.

The dark side of the picture is that all of the statistical data are reported in terms of the physical supply and not the economic supply which depends upon tree size, quality, species mix, logging costs and infra-structures providing transportation, processing, and forest maintenance facilities. Also, the volumes of mature timber reported in 1981 from earlier inventories could not be updated for growth or depletion that took place after the inventory was made — an average time of about 10 — 15 years.

The volumetric change in growing stock capital during the 1977-81 reporting period was quite low, with long-term growth exceeding depletion by 15%, providing only a 0.2% increase to the total growing stock. The failure to update earlier inventories might therefore have no significant effect upon the total growing stock volume but it could have a very major effect upon how it is distributed by age classes, and by geographic area (some provinces have suffered disasterous losses from fire and insect epidemics).

The sustainable growth component, the mean annual increment to maturity for natural forests, is a relatively stable bench-mark value from which increases from silvicultural input can be measured, or the annual growth equivalent of changes in the stocked productive area base. Bench-mark values themselves should be refined as better yield/age data for various forest conditions become available. To determine the actual current growth, major improvements in age class data and inventory methodology would be required.

Depletion, particularly the losses from fire and insects, is subject to very wide variation about the five year annual averages from one year to the next and from region to another. This limits the validity of future projections. At present, only half of the volume depletion is utilized through planned harvests, the other half is lost to fire and forest pests. Future increases in planned harvests depend greatly upon the extent to which these huge losses can be reduced by improved

protection and prevention programs. Also, the high risk of loss is a major constraint on investments in silvicultural programs designed to increase future harvests.

However, the most serious long-term losses are not in volume but in the continued erosion of the stocked productive land base. Available estimates indicate that 20% of the areas logged, burned or killed by insects and disease annually are not regenerated and go out of production; about 72% restocks by natural means and the remainder are restocked by planted or artificial seeding. Even if the estimated losses are heavily discounted to allow for possible errors from differing standards and evaluation techniques, it is evident that the present level of silvicultural input for stand renewal is well below that required.

At present there is some kind of silvicultural input on about 233 000 ha annually or about 0.1% of the total productive forest landbase. While this is a very small proportion, it is many times greater than that of 10 to 20 years ago when silvicultural activities were almost non-existent.

The major constraint on all of the silvicultural operations, apart from funding, is that the return from them is highly dependent upon species, stand and site characteristics that cannot be determined from the level of inventory data now available. Because of this, the considerable body of information available from field trials cannot be extrapolated in any meaningful quantitative way to existing forest conditions. Estimates of impact presented here are therefore largely intuitive.

In brief:

Overall, Canadian forests still contain a physical supply of mature and overmature timber available for harvest plus an adequate supply of immature stands that is sufficient to maintain or modestly expand current levels of harvest on the existing stocked productive forest land base. But, the base is being eroded by regeneration failures and land withdrawals. Data for this latter cause do not exist. To maintain the base, substantial investments in expanded forest renewal programs are required. Such investments must be safeguarded by reducing volume losses from fire, insect and disease which now almost equal the total volume harvested, and dissipate almost one-half of the long-term sustainable growth. Silvicultural input in the form of forest renewal and improvement programs have expanded greatly in the last decade, but are still so small in relation to the total forest area that they are not yet having a significant impact on current productivity.

Major constraints on the foregoing are:

- all inventory data available are expressed in terms of physical volumes and areas of standing timber and at present cannot be equated with the economic supply currently utilized.

- wide deviations about the national average for volume, growth and depletion estimates exist at the provincial and management unit levels.

- the national data base for evaluating, planning and implementing more intensive forest management operations while superior to that of former years, is still extremely weak.

and finally:

Is Canada running out of wood? Current statistics indicate that a surplus of old growth timber is available for harvest, however, these data tend to mask the local and regional shortages that do exist.

Are we planting enough trees? About 20% of the lands that are depleted annually due to harvest, fire and pests go out of production even though efforts in forest renewal have increased markedly. Silvicultural activities must be expanded if we are to maintain the 1981 land base for forestry.

Are we cutting too many? The data suggest that harvesting levels can increase to take advantage of forecasted demands for forest products, however all cutover lands must be restocked immediately to ensure continued economic prosperity from our forests.

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Appendix 1

Forest resource data

The major data sources used in this study are listed in the References. General descriptions of the major components Forest Capital, Accruals to Capital and Withdrawals of Capital and specific details pertaining to assumptions and computational methods are presented here.

Forest capital

The report entitled Canada's Forest Inventory 1981 (Bonnor 1982) is used as the major source of information on Canada's forest capital. Personal communication with all provinces resulted in some changes to the previously published area and volume figures. New data are presented for Alberta, and Prince Edward Island and the existing data for British Columbia were reworked to include the Tree Farm Licences. Minor changes to the New Brunswick figures were made upon the advice of the Department of Natural Resources.

Canada's forest capital is defined as the productive nonreserved forest land of 221.03 million ha and the growing stock volume of 21 536.29 million m^3.

Inventory data are generally gathered and reported on a ten-year cycle, however, forests growing in remote regions or in urban and developed areas may have inventory cycles that exceed ten years. New concepts and systems of inventory are also being implemented that make the cyclical inventory somewhat obsolete. All of these factors influence the age and accuracy of the data.

Table D1 shows the percent distribution of inventoried areas by the age of data and by province and territory. Information for the four maritime provinces is generally less than 10 years old with the exceptions of Newfoundland and a small area of New Brunswick. The remaining provinces have inventoried at least 80% of their resource within the last 20 years with the exception of Alberta which will have new inventory data

TABLE D1

Age of Data on Forest Capital[1]

Inventoried Areas

Province or Territory	Percent of Data Taken Years Ago		
	0 ≤ 10	10 ≤ 20	20+
Newfoundland	81	19	-
Nova Scotia	100	-	-
Prince Edward Island	100	-	-
New Brunswick	98	2	-
Quebec	82	18	-
Ontario	58	34	8
Manitoba	41	56	3
Saskatchewan	51	47	2
Alberta	17	3	80
British Columbia	56	44	-
Yukon Territory	-	100	-
Northwest Territories	44	25	31
Canada	55	35	10

1. Bonner 1982

TABLE D2

Accuracy of Data on Canada's Wood Volume[1]

Description	Wood Volume (1 000 000 m³)	Accuracy Percent
Total for Canada	23 046	± 6
Total of Inventoried Areas	19 921	± 4
Total of Provincial Inventories	19 220	± 2

1. Bonner 1982

available in 1984. The Northwest Territories uses information on 31% of its forest area that is more than 20 years old.

The accuracy of the data in any statistical report is of paramount concern, because it will influence the resulting inferences or conclusions drawn from the data. For the figures on forest capital in wood volume the sampling accuracy at the time the estimates were made is presented in Table D2; no accuracy statement is available for the area figures, however it is estimated to be comparable to the percentages shown for volume.

Accruals to forest capital

Two data sources are available concerning accruals to forest capital. Bickerstaff *et al* (1981) provides figures on the growth of Canadian forests. Brace and Golec (1982) report statistics on silvicultural practices implemented to maintain or enhance the productivity of productive forest land. The provinces of Nova Scotia, Prince Edward Island and Manitoba provided new additional data for the study.

Growth. Forest growth is quantified in terms of mean annual increment to rotation age (MAI_r). Bickerstaff *et al* (1981), provide estimates for the forest regions of Canada and average figures for each province or territory based on inventory data and other plot measurements. These MAI_r data when multiplied by the areas of stocked productive forest land, provide estimates of the annual growth that Canada's forests are capable of producing.

The mean annual increment to rotation age of naturally established unmanaged stands of average stocking is used as the index of growth for both technical and practical reasons, namely:

- Direct relationship to yield, growing stock, existing inventories and allowable cuts;
- Independent of existing age-class distributions in forest management units;
- Relative stability changing only slightly for 10 years or more, above or below rotation age;
- A simple currently attainable bench-mark or datum line level of productivity against which future increases brought about by improved management can be measured.
- Useable approximations of its magnitude can be derived from quite diverse sets of available inventory data.
- Equal to the volume of depletion that can be sustained indefinitely with an approximately normal distribution of age classes.

When the MAI_r figures for each province are multiplied by the area of land that is not satisfactorily restocked (NSR), the resulting product is an estimate of growth loss on idle productive forest lands. Table D3 summarizes the MAI_r data used in developing the growth statistics.

Growing stock. Because of the practical importance of distinguishing between softwoods and hardwoods in any comparison of growth and depletion, the mean annual increment was subdivided into softwood and hardwood components on a pro rata basis according to the proportions present in the 1981 growing stock. No difference in growth between species was taken into account.

Tables of mean annual growth on stocked productive nonreserved forest land are developed on the premise that the 1981 inventory figures for area are current, i.e., the regeneration failures have been classified as "not stocked" and the areas regenerated by planting and by natural means have been classified as "stocked."

These assumptions may not hold for all of the data.

TABLE D3

Mean Annual Increment by Province and Territory[1]

Province/Territory	Mean Annual Increment to Rotation Age (m^3/ha/a)	Range	Rotation Age (years)
Newfoundland	1.1	0.4-1.3	70-100
Nova Scotia[2]	2.3	2.0-2.5	70-100
Prince Edward Island[2]	2.1	0.5-8.0	70-100
New Brunswick	1.9	1.5-2.8	70-100
Quebec	1.6	0.8-2.7	70-100
Ontario	1.7	1.4-2.4	70-100
Manitoba[2]	1.6	0.5-2.5	70-100
Saskatchewan	1.8	0.7-2.0	70-100
Alberta	1.8	0.7-2.3	70-100
British Columbia	2.3	1.3-5.7	70-100
Yukon Territory	0.6	0.2-0.8	100
Northwest Territories	0.5	0.2-0.8	100
Canada	1.7	0.2-8.0	

1. Bickerstaff *et al.* 1981
2. New provincial information

Many provinces only update their records on a cycle of 10, 20 or 30 years as shown in Table D1. But in British Columbia, a province containing about 45% of Canada's growing stock volume, the updating cycle is continuous so that records are always current to within 6 months. It can be argued therefore that the growth figures used in this report are appropriate for the period covered.

Natural regeneration. Depleted lands, if left in an untended state will eventually regenerate to a cover of forest vegetation. This vegetative cover may take several decades to produce and may or may not be composed of commercial tree species. Productive forest land that is growing noncommercial tree species is also considered to be not satisfactorily restocked (NSR).

The report of Brace and Golec (1982) provide figures for the percentage of clearcut lands that regenerate naturally within ten years. Provincial and territorial forestry agencies provided estimates of natural regeneration on burned over lands. These data are listed in Table D4.

Statistics pertaining to the rate of regeneration on harvested lands and burned-over lands are not maintained or published on a regular basis.

Silvicultural practices. Silviculture is the art and science of tending the forest. Silvicultural practices have been implemented in many provinces but a national summary of a few selected activities only became available in 1982. These data are primarily concerned with area harvested, area of site preparation, area planted, area of direct seeding, and area of stand tending. Many of these data are based on estimates developed by Brace and Golec. Some agencies do not maintain all of the records that the national statistics program needs.

No nationwide estimates of forest capability are published for lands available for timber production. Thus the growth rates used for treated lands are the same as those of the natural forest. Procedures to estimate forest capability, developed for the Canada Land Inventory, are reported by McCormack (1967). Seven capability classes based on estimates of mean annual increment pertain to the productivity of the best species or group of species adapted to the site at or near rotation age. The rate of growth is for normal, fully stocked stands that could be produced with good forest management techniques. Unfortunately these estimates, which are benchmarks of optimum productivity, were only developed for those areas where alternative uses of marginal lands were a major factor in land use planning.

TABLE D4

Estimates of Percent Natural Regeneration Within 10 Years

Average Annual Percent of Area

Province or Territory	Clear Cut[1]	Partial[3] Cut	Scarified[3] Land	Burn[2]	Pest[3] Damaged Land	Old[3] NSR
Newfoundland	30	100	100	50	80	1
Nova Scotia	30	100	100	50	80	1
Prince Edward Island	30	100	100	50	80	1
New Brunswick	30	100	100	50	80	1
Quebec	30	100	100	67	80	1
Ontario	28	100	100	50	80	1
Manitoba	21	100	100	75	80	1
Saskatchewan	30	100	100	75	80	1
Alberta	20	100	100	75	80	1
British Columbia	30	100	100	72	80	1
Yukon Territory	30	100	100	50	80	1
Northwest Territories	30	100	100	50	80	1

1. Brace and Golec 1982
2. Provincial/Territorial Forest Agencies
3. Author's estimates

Withdrawals of forest capital

Three major sources of data are available. Records of harvest production are collected and published by Statistics Canada. The Petawawa National Forestry Institute collates and publishes the annual statistics on forest fires. Losses attributable to forest pests are collected and reported by the Forest Insect and Disease Survey, Canadian Forestry Service.

The basic depletion data for cutting, fire and forest pests are currently reported either in terms of volume or area. Ideally both volume and area should be measured and recorded to maintain up-to-date inventories, but because of practical difficulties in so doing, available statistics report only volume or only area.

The area and volume standards used in reporting depletion also vary greatly. For example: fire statistics report the gross area of forest land burned and include nonproductive areas such as muskeg, rock barrens, etc., on all forest land, whereas the cut or harvest reports give the utilized volume on nonreserved productive forest land. Therefore, to make the available reported statistics approximately comparable it is necessary to transform them to a common base.

The common base adopted for area is the stocked productive nonreserved forest land from which the current growing stock has been depleted. For the volume base, the volume harvested is that reported as utilized; for insects and disease the volume of mortality pertains to the forests available for harvest. Where only volume or only area was reported the missing statistic was approximated by using the appropriate average yield in cubic metres per hectare from Appendix 4, Tables 1.2 or 1.3 to compute a "derived" area or volume equivalent for the missing variable. Thus for each province and territory, roughly comparable paired area-volume depletion statistics are presented.

These approximations have obvious shortcomings, but until more sophisticated and systematic depletion data are available, they do serve to bring existing statistics to a simple common base. Data characteristics or limitations peculiar to either cutting, fire or forest pests are indicated in the presentation of their statistics. However, there is a general limitation which cannot be isolated in the available data, i.e., the possibility of double counting. For example, cutover areas and those subject to severe insect infestations may sometimes be burned over later. Overall, the inflation

of the total depletion from double counting is not likely to exceed 5%.

Harvest. Records of forest harvest (Statistics Canada) report the species cut, the net volume of wood utilized and the general product (roundwood, sawlogs, fuelwood etc.). No data on areas harvested are provided. Most provincial or territorial agencies maintain these area figures in their district and regional offices but they are not always available at the provincial reporting level. The areas of harvest used in this study are those reported by Brace and Golec (1982).

The annual allowable cut (AAC) is the volume of timber that can be harvested annually on a perpetual basis. It is usually computed for a specified period, i.e., five years, and is based on assumptions concerning annual growth, losses to forest pests and wild fire and the maintenance of the land base for timber production. The AAC can be raised if the levels of forest growth, forest renewal and protection and utilization are increased and it can be lowered if land is withdrawn from forestry uses or if pest and fire losses become epidemic.

The areas and volumes harvested for the period 1975-1980 are shown in Appendix 4, Table 3.1, and a comparison of the average annual harvest with the AAC is presented in Appendix 4, Table 3.1.1.

Fire. Annual fire statistics primarily report the number of fires, their cause and the area of forest land that was burned. These data are maintained by each province and the national effort in this area is coordinated by the Canadian Committee on Forest Fire Control. Clark (1983) has summarized these data for the period 1977-1981.

There are two major factors that condition the use of fire statistics in assessing the depletion of Canada's forests. First, the total area burned includes both productive and non productive forest land. Second, the statistics provide no estimates of volume of wood destroyed.

For the purpose of this report it was necessary to develop estimates of burned area on forest land available for timber production. This was done by adding the areas of burn[1] reported under classes "merchantable timber," and "regeneration and immature" for the years 1977-1981 and deriving an average annual area burned for the five year period. These areas are shown in Appendix 4, Table 3.2.

Very little information is available on the volume of wood killed by fire. Because of this, a burned volume equivalent was derived for each province. The area of stocked productive nonreserved forest land that was burned, was multiplied by the average yield per hectare for inventoried lands as shown in Appendix 4, Table 1.2. Results are tabulated in Appendix 4, Table 3.2

Pests. National estimates of the losses resulting from infestations by insect and disease are available in the report "Forest Insect Conditions in Canada 1981" by Sterner and Davidson (1982). This publication is a consolidation of damage and depletion information provided by the Forest Insect and Disease Survey staff in the six regional establishments of the Canadian Forestry Service. Internal reports of the Canadian Forestry Service were used to provide estimates of losses due to mortality from individual pests, by province/territory.

Losses from insect and disease are much more difficult to quantify than depletion by cutting and fire, and the methodology is still being developed. Problems arise mainly because of the following factors:

- Both insect and disease damage tends to build up over a period of years and the mortality resulting from it may also occur over a considerable time spread.
- In stands of a single species not all trees may be affected, and in mixed stands even the complete loss of a single species only partially depletes the stand.
- Some of the mortality associated with insects or disease cannot be separated realistically from the normal mortality that results from inter-tree competition or in overmature stands from their natural decadence or normal life span of trees.
- Some of the differences reported between regions may reflect differences in damage appraisal techniques still under development rather than real differences.

The area equivalents of the mortality are computed using the volume of mortality divided by the Yield Available for Harvest as set out in Appendix 4, Table 1.3. These hypothetical computed values are much smaller than the total areas of the infestations because of the partial damage within stands and between species and its spread over time.

Salvage. Salvage operations generally take place on areas devastated by major fires or pest outbreaks. It is an attempt to utilize the damaged timber for economic gain before insects, disease and decay render it useless.

Most forestry agencies conduct salvage operations

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[1] Detailed data were provided by G.S. Ramsey, Petawawa National Forestry Institute, Chalk River, Ontario.

TABLE D5

Area Salvaged as a Percentage of Depleted Area by Cause[1]

Average Annual Values 1977-1981

Province or Territory	% Salvaged Burns	% Salvaged Pests
Newfoundland	2	35
Nova Scotia	25	35
Prince Edward Island	80	40
New Brunswick	25	35
Quebec	20	20
Ontario	1	1
Manitoba	3	3
Saskatchewan	3	3
Alberta	3	4
British Columbia	50	70
Yukon Territory	-	-
Northwest Territories	-	-

1. Provincial/Territorial Forestry Agencies.

depending upon the severity and extent of the attack on the forest. However, statistics on the volume of wood salvaged are not differentiated from the statistics on wood harvested. No area figures are reported. In an attempt to determine the extent of this operation, the provincial and territorial forestry agencies were contacted and provided the area estimates of salvage for burns and pests shown in Table D5. These data were used in conjunction with the total areas lost to fire and pests to approximate the areas salvaged.

The volume of wood salvaged on these operations was estimated at 30% yield for burn salvage areas and 60% of yield for pest salvage areas.

Period of study

The forest inventory of Canada is taken and published every five years (Revised Statutes of Canada 1971). The period covered by this report is 1977-1981.

In terms of forest change, it is a relatively short interval to detect trends and assess their affect on the resulting volume-area balance. However, because official statistics on silvicultural activities and pest damage became available for the first time, it was appropriate to assess their usefulness in evaluating the overall forestry situation in Canada. The growth-depletion figures used in this report are averages based on totals for a five-year period. Ideally the years involved in the period remain constant, however in this study the years differ for some components because of variable reporting dates. For example, the data on silvicultural activities such as tree planting and stand tending are given for the period 1975-1979, whereas the statistics for pest losses are for the period 1977-1981. These differences may have a slight influence on the resulting volume-area balance; subsequent studies will have standard reporting periods.

The periods related to each component are shown in Table D6.

TABLE D6

Year of Inventory and Periods of Change

Description	Period or Year	Comments
Forest Capital Inventory	1981	45% of data are more than 10 years old.
Accruals to Capital		
Growing Stock Growth	1977-1981	MAI_T is a measure of long-term growth and is not influenced by age of data.
Natural Regeneration	-	Correlated to depletion from harvest, burns, and pests.
Silvicultural Practices	1975-1979	First five-year report
Depletion of Capital	1975-1979	Area data are taken from silviculture statistics.
Harvest		
Burn	1977-1981	Estimates of merchantable volume destroyed.
Pests	1977-1981	Volume of mortality only. Area equivalents were derived.

Appendix 2

Terms and definitions

These terms and definitions are largely taken from the references that follow; if no number is given in brackets at the end of a definition, the definition is specific to this report.

References.

1. Bonnor M.G. 1978. A Guide to Canadian Forest Inventory Terminology and Usage. (2nd ed.). Published for the Canadian Forest Inventory Committee by the Canadian Forestry Service, Dept. Environment. 57 pp.

2. Society of American Foresters (SAF): Forestry Terminology, 3rd ed. Published by SAF, Washington, D.C., 1958.

3. Society of American Foresters (SAF): Terminology of Forest Science, Technology Practice and Products. Multilingual Forestry Terminology Series No. 1, Published by SAF, Washington, D.C., 1971.

4. Empire Forestry Association (EFA): British Commonwealth Forest Terminology, Part 1. Published by EFA, London, England, 1953.

5. Brace L.G. and P.J. Golec 1982. Silviculture Statistics For Canada, 1975-80 North. For. Res. Cent. Info Rep. NOR-X-245. Can. For. Serv., Dept Environment. Edmonton, Alta.

Age

Even-aged: Of a forest, stand, or forest type in which small age differences exist between individual trees (1). The maximum differences in age permitted is usually 10-20 years; if the stand will not be harvested until it is 100-200 years old, larger differences up to 25% of the rotation age may be allowed (1).

Uneven-aged: Of a forest, stand, or forest type in which intermingling trees differ markedly in age (3).

The minimum difference in age permitted in an uneven-aged stand is usually 10-20 years.

Burn (Burned-over): Land that has recently been burned (1).

Cleaning: a cultural operation in stands not past the sapling stage of eliminating or suppressing (slashing) undesireable vegetation mainly woody so as to favor the better trees. (3).

Clear cut: A silvicultural system in which the old crop is cleared over a considerable area at one time (3).

Cutover: An area of forest land from which some or all the timber has recently been cut (1).

Fertilizing: The addition of nutrients to the soil (in organic or inorganic form) (5).

Forest Inventory Type:

Reconnaissance: An exploratory, extensive forest inventory with no detailed estimates obtained (1). A formal sampling design is generally not used, and no precision estimates are obtained.

Regional: A detailed, extensive forest inventory for planning on a regional or provincial basis (1). Major forest types are usually mapped, with estimates given for each type. Precision estimates given for total inventory volume.

Management: A detailed, intensive forest inventory for management purposes, of an area managed as one unit (1). The forest types are usually mapped in detail with estimates given for each type. Precision estimates given for total inventory volume.

Operational: An intensive forest inventory of a small area for harvesting purposes (1). Individual stands are mapped, with estimates given for each stand.

Forest Types

Softwood: A forest type in which 76-100% of the canopy is coniferous.

Mixedwood: A forest type in which 26-75% of the canopy is coniferous.

Hardwood: A forest type in which 0-25% of the canopy is coniferous.

Land Status

Reserved (Land): Forest land that by law or policy is not available for the harvesting of forest crops (1). Also referred to as **Alienated Land**.

Nonreserved (Land): Forest land that by law or policy is available for the harvesting of forest crops (1).

Federal Land: Crown land within the jurisdiction of the federal government.

Provincial Land: Crown land within the jurisdiction of a provincial government.

Private Land: Land that is not the property of the Crown (1).

Maturity Class

Regeneration: The renewal of a forest crop by natural or artificial means. Also the new crop so obtained (4). The new crop is generally less than one metre in height.

Immature: In even-aged management, those trees or stands that have grown past the regeneration stage, but are not sufficiently developed to be harvestable (except for thinning operations) (1).

Mature: Stands or forest types at or near rotation age. Growth has culminated.

Overmature: Stands or forest types past rotation age. Openings in canopy as a result of mortality becoming apparent.

Pests: Insects and diseases causing damage and mortality to trees growing on forest land.

Pest control: Reduction or elimination of harmful insect or disease populations by chemical, biological, or mechanical means (5).

Productivity

Productive: Forest land that is capable of producing a merchantable stand within a reasonable length of time (1).

Unproductive: Forest land that is incapable of producing a merchantable stand within a reasonable length of time (1), and specifically having a site index rating of less than 5 m at base age 50. Includes muskeg, rock, barrens, marshes, meadow, etc. within forest land area.

Pruning: The removal of live or dead branches from the bole of a tree for a variety of reasons e.g. to improve access or the quality of lumber sawn from the bole (5).

Scarification: Loosening the top soil of open areas, or breaking up the forest floor, in preparation for artificial or natural regeneration (3).

Seeded: the artificial sowing of seeds in an area by manual or mechanical means (5).

Broadcast seeding: The scattering of seed more or less evenly over a whole area on which a forest stand is to be raised (3).

Natural seeding: The seeding of an area by natural means, i.e. from slash borne seeds or from standing, seed-producing trees (5).

Partial-seeding: Seeding confined to limited areas, e.g., drills, strips, patches (spots), nests, generally according to a regular spatial pattern (5).

Site Capability: The mean annual increment in merchantable volume that can be expected for a forest area, assuming it is fully stocked by one or more species best adapted to the site, at or near rotation age (1). Expressed in cubic metres per hectare.

Site Quality: A measure of the relative productive capacity of a site for one or more species (1).

Stocking: A qualitative expression of the adequacy of tree cover on an area, in terms of crown closure, number of trees, basal area, or volume, in relation to a preestablished norm (1). In this context, tree cover includes seedlings and saplings, hence the concept carries no connotation of a particular age.

Degree of stocking may be classified as:
(a) Stocked versus Nonstocked;
(b) Understocked, Fully Stocked, or Overstocked. It may also be expressed as a percentage of the preestablished norm or stocking factor.

Stocked Forest Land: Land supporting tree growth (1). In this context, tree growth includes seedlings and saplings.

Not Satisfactorily Restocked (NSR) Forest Land: lands that have failed to regenerate adequately within 10 years of harvest or destruction.

Thinning: A felling made in an immature crop or stand in order primarily to accelerate diameter increment but also, by suitable selection to improve the average form of the trees that remain (3).

Undetermined: Data not available or not relevant. (1).

Weeding: Generally, a cultural operation eliminating or suppressing undesireable vegetation, mainly herbaceous, during the seedling stage of a forest crop and therefore before the first cleaning, so as to reduce competition with the seedling stand. If it is done with chemicals, it is termed chemical weeding. (3).

APPENDIX 3

PROVINCIAL AND TERRITORIAL MERCHANTABILITY STANDARDS

	Minimum Tree Size (diameter at breast height) outside bark	Stump Height	Minimum Top Diameter (inside bark)
	---------- cm ----------		
Newfoundland	9.0	15	7.6
Prince Edward Island*	9.0	25	8.0
Nova Scotia	9.0	variable, average is 10	9.0
New Brunswick	12.0	30	7.0
Quebec	9.0	15	9.0
Ontario	10.2	30	7.0
Manitoba	9.1	30	7.6
Saskatchewan	9.1	30	7.6
Alberta	10.2	30	7.6
British Columbia**	17.5	30	10.0
Yukon Territory	9.1	30	7.6
Northwest Territories	10.2	30	10.2

* P.E.I. reports gross total volume

** B.C. reports net merchantable volume (reduced for defect and cull) All other provinces/territories report gross merchantable volume that has not been reduced for defect.

Provincial and territorial forest inventory characteristics

Newfoundland: In the Newfoundland Management Inventory, no volumes are obtained from immature forests.

Prince Edward Island: Volumes are gross total. Classification of data by ownership, status, age, and site is not yet available.

Nova Scotia: Because of the recent spruce budworm epidemic significant forest changes have taken place but have not yet been measured. Hence no details are given for Cape Breton.

New Brunswick: The inventory data are not available by site classes.

Quebec: The inventory data are not available by site classes.

Ontario: The new inventory of southern Ontario is currently underway. Data are not yet available.

Manitoba: The southwest corner of the province is being inventoried. Preliminary figures indicate unexpectedly high forest areas and hardwood volumes on the private, predominantly agricultural lands. These changes will be incorporated in the next national report.

Saskatchewan: The province intends to have the commercially available forest classified by age and site before 1986.

Alberta: The data given are old data, of doubtful accuracy. New inventory data will be available in 1984.

British Columbia: Volumes are net merchantable. The data includes an estimate of private forest land that is inventoried but not available for computer summary.

Yukon Territory: A reconnaissance inventory of all forest land is currently in progress and will be completed by 1986.

Northwest Territories: A reconnaissance inventory of a major part of the NWT was completed in 1981.

Appendix 4

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KEY TO SYMBOLS USED IN TABLES

- Nil or Zero
-- Too small to be expressed
.. Not Available
... Not Applicable
[ ] Estimate

Table 1.1 Forest Capital in Land Area and Wood Volume

Province or Territory	NATIONAL LAND BASE			TOTAL PRODUCTIVE FORESTS[1]		ALIENATED LANDS	LAND STATUS UNDETERMINED	FORESTS AVAILABLE[2] FOR TIMBER PRODUCTION		NONINVENTORIED LANDS[3]	
										Productive and Nonproductive Forests	
	Total Area	Land Area 1 000 000 ha	Forest Land Area	Land Area 1 000 000 ha	Wood Volumes 1 000 000 m³	Area 1 000 000 ha	Area 1 000 000 ha	Land Area 1 000 000 ha	Wood Volume 1 000 000 m³	Land Area 1 000 000 ha	Wood Volume 1 000 000 m³
Newfoundland	40.5	37.1	14.2	8.5	464	0.2	-	8.3	463	-	-
Nova Scotia	5.5	5.3	4.1	2.9	219	--	0.9	2.9	202	-	-
Prince Edward Island	0.6	0.6	0.3	0.3	33	-	-	0.3	33	-	-
New Brunswick	7.3	7.2	6.5	6.2	516	--	-	6.2	516	-	-
Quebec	154.1	135.7	94.0	84.9	4 929	0.1	--	53.3	4 133	31.6	790
Ontario	106.9	89.1	80.7	42.6	3 599	0.4	9.8	36.8	3 198	4.9	308
Manitoba	65.0	54.8	34.9	13.9	745	0.4	-	13.6	634	6.7[4]	103
Saskatchewan	65.2	57.0	17.8	8.9	608	1.2	-	7.9	484	5.5	84
Alberta	66.1	64.4	39.0	23.6	1 696	3.4	-	20.4	1 545	1.8	54
British Columbia	94.9	93.1	63.3	51.5	9 731	1.0	-	50.8	9 628[5]	-	-
Yukon Territory	48.2	47.8	24.2	6.7	255	0.2	17.3	6.7	255	-	-
Northwest Territories	338.0	324.6	61.5	14.3	446	1.1	-	13.8	446	-	-
Canada[6]	992.2	916.7	440.5	264.3	23 241	7.9	28.0	221.0	21 536	50.5	1 339

NOTES:

1. Bonnor 1982 and Provincial Forest Agencies.
2. Productive nonreserved forest land.
3. Non inventoried lands and northern forests.
4. Estimate based on Saskatchewan data.
5. Includes Tree Farm Licences.
6. Totals may not add due to rounding.

Table 1.2 Growing Stock Areas and Volumes on Forests Available for Timber Production 1981.

Province or Territory	LAND AREA FOR TIMBER PRODUCTION[1] 1 000 000 ha						GROSS MERCHANTABLE VOLUME ON STOCKED LAND 1 000 000 m³			AVERAGE YIELD ON STOCKED LAND		
	Total	N.S.R.	Undetermined	Natural Forest	Man-made[6] Forest	Stocked Forest	Swd.[8]	Hwd.[9]	All Species	m³/ha	%Swd.	%Hwd.
Newfoundland	8.35	0.47	-	7.86	[0.02]	7.88	428.89	34.11	463.00	58.7	92.6	7.4
Nova Scotia[2]	2.89	0.04	-	2.83	[0.02]	2.85	136.86	65.60	202.46	71.1	67.6	32.4
Prince Edward Island[3]	0.29	0.04	-	0.24	[0.01]	0.25	22.23	11.10	33.32	134.4	66.7	32.3
New Brunswick	6.17	0.29	-	5.81	[0.08]	5.89	337.58	178.34	515.92	87.7	65.4	34.6
Quebec	53.28	4.40	- -	48.56	[0.31]	48.87	3 089.28	1 043.53	4 132.81	84.6	74.8	25.2
Ontario[4]	36.82	3.74	-	31.88	[1.20]	33.08	2 074.72	1 122.88	3 197.60	96.7	64.9	35.1
Manitoba	13.62	1.80	-	11.75	[0.08]	11.83	438.58	195.80	634.37	53.6	69.1	30.9
Saskatchewan	7.95	0.59	-	7.18	[0.18]	7.36	293.47	190.55	484.02	65.7	60.6	39.4
Alberta	20.41	5.77	-	14.47	[0.18]	14.65	964.91	579.82	1 544.73	105.5	62.5	37.5
British Columbia[5]	50.77	2.97	0.76	46.27	[0.78]	47.05	9 131.88	496.06	9 627.95	204.6	94.8	5.2
Yukon Territory[7]	6 73	1.80	-	4.93	-	4.93	214.63	39.92	254.55	51.7	84.3	15.7
Northwest Territories[7]	13.76	0.02	- -	13.74	-	13.74	314.71	130.87	445.58	32.4	70.6	29.4
Canada[10]	221.03	21.91	0.76	195.50	[2.86]	198.36	17 447.74	4 088.58	21 536.31	108.6	81.0	19.0

NOTES:

1. Bonnor (1982) and Provincial Forest Agencies.
2. Excludes Cape Breton Island
3. Includes abandoned agricultural land.
4. Excludes southern Ontario below 45° Latitude
5. Includes Tree Farm Licences.
6. Estimates in square brackets based on Cayford and Bickerstaff 1968.
7. Most burned lands and NSR lands were classified as unproductive forest land in 1980 reconnaissance inventory.
8. Softwoods
9. Hardwoods
10. Totals may not add due to rounding.

Table 1.3 Area and Growing Stock Maturity Classification — **Stocked Productive Nonreserved Forest Land**

MATURITY CLASSES ON STOCKED LAND[1]

A = Area in 1 000 000 ha V = Volume in 1 000 000 m³ Y = Yield in m³/ha

Province or Territory	REGENERATION			IMMATURE			AVAILABLE FOR HARVEST[2]			TOTALS		
	A	V	Y	A	V	Y	A	V	Y	A	V	Y
Newfoundland	[0.39]	-	...	[1.29]	..	..	[6.20]	463.00	[74.7]	7.88	463.00	58.7
Nova Scotia	0.07	0.78	...	0.36	12.16	34.3	2.42	189.52	78.2	2.85	202.46	71.1
Prince Edward Island[3]	0.02	-	...	0.12	13.80	120.0	0.12	19.52	230.0	0.25	33.32	134.4
New Brunswick	1.81	107.63[4]	...	0.77	46.13	60.3	3.31	362.16	109.3	5.89	515.92	87.7
Quebec	6.95	160.19	...	14.07	1 148.68	81.7	27.85	2 823.94	101.4	48.87	4 132.81	84.6
Ontario	1.65	16.70	...	23.27	2 150.95	92.4	[8.16]	1 029.95	[126.2]	33.08	3 197.60	96.7
Manitoba[3]	1.15	-	...	8.48	371.19	43.8	2.20	263.18	119.7	11.83	634.37	53.6
Saskatchewan	[1.72]	-	...	[3.92]	[180.25]	[45.9]	[1.72]	303.77	[176.3]	7.36	484.02	65.7
Alberta	1.56	1.17	...	9.02	979.34	108.5	[4.06]	564.22	[138.97]	14.65	1 544.73	105.5
British Columbia	[2.14]	[1.74]	...	[18.55]	[1 925.68]	[103.8]	[26.35]	[7 700.53]	[292.2]	47.05	9 627.95	204.7
Yukon Territory	1.96	-	...	2.62	209.50	79.9	[0.34]	45.05	131.7	4.93	254.55	51.7
Northwest Territories	0.73	-	...	8.61	143.76	16.7	4.41	301.82	68.5	13.74	445.58	32.4
Canada[5]	20.14	288.21	...	91.08	7 181.44	80.0	87.14	14 066.66	161.4	198.36	21 536.31	108.6

NOTES:

1. Area is distributed after Bonnor 1982. Author's estimates in square brackets.
2. Volumes classified as undetermined are added to volumes mature, overmature and uneven-aged to give volume Available For Harvest.
3. New provincial data.
4. Includes volumes of residual hardwoods remaining on cut-over lands.
5. Totals may not add due to rounding.

Table 1.4 Distribution of Forest Capital Relative to Maturity Class and Stocking

Productive Nonreserved Forest Land

Province or Territory	LAND AREA FOR TIMBER PRODUCTION	PERCENT OF LAND AREA						GROSS MERCHANTABLE VOLUME	PERCENT OF GROSS MERCHANTABLE VOLUME BY MATURITY CLASS		
		MATURITY CLASS			STOCKING				MATURITY CLASS		
	1 000 000 ha	Regeneration	Immature	Available for Harvest	Stocked	Not Stocked	Undetermined	1 000 000 m³	Regeneration[2]	Immature	Available for Harvest
Newfoundland	8.35	[5][1]	[15]	[74]	94	6	-	463.00	-	-	100
Nova Scotia	2.89	2	12	84	98	2	-	202.46	--	6	94
Prince Edward Island	0.29	6	46	48	87	13	-	33.32	-	41	59
New Brunswick	6.17	--	41	54	95	5	-	515.92	-	30	70
Quebec	53.28	13	26	52	92	8	--	3 132.81	4	28	68
Ontario	36.82	4	63	[22]	90	10	-	3 197.60	1	67	32
Manitoba	13.62	8	62	16	87	13	-	634.37	-	59	41
Saskatchewan	7.95	[22]	[49]	[22]	93	7	-	484.02	-	37	63
Alberta	20.41	8	45	[14]	67	33	-	1 544.73	--	70	30
British Columbia	50.77	5	39	56	93	6	1	9 627.95	--	20	80
Yukon Territory	6.73	29	39	5	73	27	-	254.55	-	82	18
Northwest Territories	13.76	5	63	32	99	1	--	445.58	-	32	68
Canada[3]	221.03	9	41	39	90	10	--	21 536.31	1	33	66

NOTES:

1. Figures in square brackets are author's estimates.
2. Includes volumes of residual hardwoods remaining on cut-over lands.
3. Totals may not add due to rounding.

Table 1.5 NSR Forest Land Areas by Disturbance and Years — Productive Nonreserved Forest Land

Disturbance	PERIODS AND AREAS[1] 1 000 000 ha Up to 1960	1961-1965	1966-1970	1971-1975	1976-1980	Total	Percent of National Total
Cutover	..	0.001	0.272	1.075	0.454	1.802	8
Burn	0.006	0.032	2.001	2.171	0.808	5.017	23
Pest	..	..	..	0.012	0.013	0.025	..
Other	..	0.471	1.223	1.566	0.409	3.669	17
Undetermined	5.225	1.453	1.488	1.631	1.604	11.401	52
Canada[2]	5.231	1.956	4.984	6.456	3.287	21.914	100
Five-year Average		0.391	0.997	1.291	0.657		

NOTES:

1. Bonnor 1982 and Provincial Forestry Agencies.
2. Totals may not add due to rounding.

Table 1.6 N.S.R. Forest Land Areas by Disturbance and Province or Territory — Productive Nonreserved Forest Land

Province or Territory	DISTURBANCE CLASS[1] 1 000 000 ha Cutover	Burn	Pest	Other	Undetermined	Total	Percent of National Total
Newfoundland	0.285	0.121	0.024	0.035	0.003	0.467	2
Nova Scotia	..	..	..	..	0.044	0.044	..
Prince Edward Island	0.011	0.001	..	0.025	-	0.037	..
New Brunswick	0.124	0.027	..	0.136	-	0.287	1
Quebec	1.311	2.613	0.002	0.383	0.096	4.404	20
Ontario	0.001	..	..	..	3.734	3.735	17
Manitoba	..	..	..	..	1.799	1.799	8
Saskatchewan	0.068	0.418	..	0.099	-	0.585	3
Alberta	..	0.023	..	0.017	5.725	5.765	26
British Columbia	..	..	..	2.973	-	2.973	14
Yukon Territory	..	1.798	..	..	-	1.798	8
Northwest Territories	0.003	0.016	..	..	-	0.019	..
Canada[2]	1.802	5.017	0.025	3.669	11.402	21.914	100

NOTES:

1. Bonnor 1982 and Provincial Forestry Agencies
2. Totals may not add due to rounding.

Table 2.1 Estimates of Mean Annual Growth to Volume of Forest Capital — **Stocked Productive Nonreserved Forest Land**

Province or Territory	Area of Growing Stock 1 000 000 ha	MAI_r[1] Average $m^3/ha/a$	MEAN ANNUAL GROWTH TO ROTATION AGE (1 000 000 m^3) NATURAL FOREST Swds.	Hwds.	All Species	MAN-MADE FORESTS All Species	ALL FORESTS Swds	Hwds	All Species	% OF NATIONAL TOTAL Swds	Hwds	All Species
Newfoundland	7.88	1.1	8.01	0.64	8.65	0.02	8.03	0.64	8.67	2.4	0.2	2.6
Nova Scotia[2]	2.85	2.3	4.38	2.13	6.51	0.05	4.43	2.13	6.56	1.3	0.6	1.9
Prince Edward Island	0.25	2.1	0.33	0.18	0.50	0.02	0.35	0.18	0.53	0.1	0.1	0.2
New Brunswick	5.89	1.9	7.17	3.87	11.04	0.15	7.32	3.87	11.19	2.2	1.1	3.3
Quebec	48.87	1.6	57.95	19.74	77.70	0.50	58.45	19.74	78.19	17.3	5.8	23.1
Ontario	33.08	1.7	35.17	19.03	54.20	2.04	36.49	19.75	56.24	10.8	5.8	16.6
Manitoba[2]	11.83	1.6	13.00	5.80	18.80	0.13	13.08	5.85	18.93	3.9	1.7	5.6
Saskatchewan	7.36	1.8	7.83	5.09	12.92	0.32	8.03	5.22	13.25	2.4	1.3	3.9
Alberta	14.65	1.8	16.27	9.78	26.05	0.32	16.47	9.90	26.37	4.9	2.9	7.8
British Columbia	47.05	2.3	100.84	5.58	106.42	1.79	102.64	5.58	108.22	30.4	1.6	32.0
Yukon Territory	4.93	0.6	2.51	0.45	2.96	-	2.51	0.45	2.96	0.8	0.1	0.9
Northwest Territories	13.74	0.5	4.85	2.02	6.87	-	4.85	2.02	6.87	1.4	0.6	2.0
Canada[3]	198.36	1.7	258.31	74.31	332.62	5.34	262.65	75.33	337.98	77.9	22.1	100.0

NOTES:

1. Mean annual increment to rotation age from Bickerstaff, *et al.* 1981.
2. New provincial data.
3. Totals may not add due to rounding.

Table 2.2 Forests Renewed by Planting and Seeding 1975-1979

Stocked Productive Nonreserved Forest Land

Province or Territory	MEAN ANNUAL AREAS RENEWED[1] ha			MEAN ANNUAL INCREMENT TO ROTATION AGE	ANNUAL GROWTH Gross Merchantable Volume 1 000 000 m³			% OF NATIONAL TOTAL			
	Planted	Seeded	Total Area Renewed	Average m³/ha/a	Swd.	Hwd.	All Species	Area	% Swd.	% Hwd.	All Species
Newfoundland	37	-	37	1.1	..	-	..	..	..	-	..
Nova Scotia	2 190	43	2 233	2.3	..	-	..	1.3	..	-	..
Prince Edward Island	108	-	108	2.1	..	-	..	0.1	..	-	..
New Brunswick	10 146	214	10 360	1.9	0.02	-	0.02	6.2	6.3	-	6.3
Quebec	15 184	4 665	19 849	1.6	0.03	-	0.03	12.0	9.4	-	9.4
Ontario	28 221	25 435	53 656	1.7	0.09	-	0.09	32.3	28.1	-	28.1
Manitoba	957	677	1 634	1.6	..	-	..	1.0	..	-	..
Saskatchewan	5 300	-	5 300	1.8	0.01	-	0.01	3.2	3.1	-	3.1
Alberta	6 342	6 400	12 742	1.8	0.03	-	0.03	7.7	9.4	-	9.4
British Columbia	60 177	-	60 177	2.3	0.14	-	0.14	36.2	43.8	-	43.8
Yukon Territory	-	-	-	0.6	-	-	-	-	-	-	-
Northwest Territories	-	-	-	0.5	-	-	-	-	-	-	-
Canada[2]	128 662	37 434	166 096	1.7	0.32	-	0.32	100.0	100.0	-	100.0

NOTES:

1. Average annual areas renewed 1975-1979 from Brace and Golec 1982
2. Totals may not add due to rounding.

Table 2.3 Forest Lands Treated by Fertilizing, Thinning and Pruning 1975-1979 — **Stocked Productive Nonreserved Forest Land**

Province or Territory	MEAN ANNUAL AREAS TREATED[1] ha					MEAN ANNUAL[2] INCREMENT TO ROTATION AGE	GROSS MERCHANTABLE VOLUME 1 000 000 m³			% OF NATIONAL TOTAL			
	Fertilizing	Thinning	Pruning	Other	Treatments	(m³/ha/a)	Swd.	Hwd.	All Species	Area	%Swd.	%Hwd.	All Species
Newfoundland	23	1 140	..	423[3]	1 589	1.1	..	-	..	2.4	..	-	..
Nova Scotia[6]	..	620	..	1 420[4]	2 432	2.3	0.01	-	0.01	3.6	8.3	-	8.3
Prince Edward Island	..	..	..	..	4	2.1	-	-	-	..	-	-	-
New Brunswick	..	..	..	..	664	1.9	..	-	..	1.0	..	-	..
Quebec	..	..	..	..	..	1.6	..	..	..	..	..	..	..
Ontario	625	19 473	1 454	20 838[4]	42 390	1.7	0.07	-	0.07	63.4	58.3	-	58.3
Manitoba	..	..	..	..	468	1.6	..	-	..	0.7	..	-	..
Saskatchewan	..	..	..	..	28	1.8	..	-	..	..	..	-	..
Alberta	..	..	..	..	319	1.8	..	-	..	0.5	..	-	..
British Columbia	4 534	11 663	-	2 779[5]	18 975	2.3	0.04	-	0.04	28.4	33.3	-	33.3
Yukon Territory	-	-	-	-	-	0.6	-	-	-	-	-	-	-
Northwest Territories	-	-	-	-	-	0.5	-	-	-	-	-	-	-
Canada[7]	5 182	32 892	1 454	25 461	66 869	1.7	0.12	-	0.12	100.0	100.0	-	100.0

NOTES:

1. Mean annual areas treated 1975-1979 from Brace and Golec 1982.
2. Mean annual increment to rotation age from Bickerstaff *et al.* 1981.
3. Stand reclamation.
4. Manual, mechanical and chemical cleaning.
5. Mechanical weeding.
6. New provincial data.
7. Totals may not add due to rounding.

Table 2.4 Natural Regeneration and Annual Accruals of Area and Volume to Forest Capital 1975-1979

Stocked Productive Nonreserved Forest Land

Province or Territory	AREA OF NATURAL REGENERATION 1 000 ha								MEAN ANNUAL INCREMENT TO ROTATION AGE	MEAN ANNUAL VOLUME GROWTH (1 000 000 m³)			% OF NATIONAL TOTAL			
	Clear[1] Cut	Partial[2] Cut	Harvest Lands	Burns[3]	Pest Damaged[4] Lands	Old[5] NSR	Scarif-[6] ication	Total	(m³/ha/a)	Swd[7]	Hwd.	Total	Area	Volume %Swd.	%Hwd.	All Species
Newfoundland	4.80	-	4.80	1.58	27.99	2.59	0.37	37.33	1.1	0.03	0.01	0.04	2.3	1.1	0.4	1.5
Nova Scotia	8.86	-	8.86	0.13	25.80	0.24	1.39	36.42	2.3	0.05	0.03	0.08	2.3	1.8	1.1	2.9
Prince Edward Island	1.23	-	1.23	--	--	0.21	0.31	1.57	2.1	--	--	--	0.1	--	--	--
New Brunswick	27.77	-	27.27	0.24	10.18	1.59	13.12	52.90	1.9	0.07	0.03	0.10	3.3	2.6	1.0	3.6
Quebec	47.89	35.98	83.87	4.46	101.11	24.46	7.17	221.07	1.6	0.26	0.09	0.35	13.8	9.5	3.3	12.8
Ontario	38.00	55.31	93.31	50.50	210.68	20.74	38.72	413.95	1.7	0.46	0.24	0.70	25.9	16.8	8.7	25.5
Manitoba	4.00	-	4.00	100.47	4.74	9.99	4.05	123.25	1.6	0.14	0.06	0.20	7.7	5.1	2.2	7.3
Saskatchewan	4.39	-	4.39	235.23	5.82	3.25	3.21	251.90	1.8	0.26	0.19	0.45	15.8	9.5	6.9	16.4
Alberta	4.30	-	4.30	224.29	5.49	32.02	16.57	282.67	1.8	0.36	0.15	0.51	17.8	13.1	5.5	18.6
British Columbia	44.85	27.11	71.96	10.50	7.91	16.51	16.94	123.82	2.3	0.27	0.01	0.28	7.7	9.9	0.3	10.2
Yukon Territory	0.05	0.48	0.53	20.82	-	9.99	0.05	31.39	0.6	0.02	--	0.02	2.0	0.7	--	0.7
Northwest Territories	0.19	-	0.19	20.71	-	0.11	-	21.01	0.5	0.01	--	0.01	1.3	0.4	--	0.4
Canada[8]	186.33	118.88	305.21	668.93	399.72	121.71	101.72	1 597.29	1.7	1.93	0.81	2.74	100.0	70.5	29.4	100.0

NOTES:

1. Percentage figures from Brace and Golec applied to provincial areas of clearcut; Newfoundland - 30%; Nova Scotia - 30%; Prince Edward Island - 75%; New Brunswick - 30%; Quebec - 30%; Ontario - 28%; Manitoba - 21%; Saskatchewan - 30%; Alberta - 20%; British Columbia - 30%; Yukon Territory - 30%; Northwest Territories - 30%.
2. Areas of partial cut are assumed to regenerate completely.
3. Burned areas are assumed to regenerate naturally within ten years at the following rates; Newfoundland - 50%; Nova Scotia - 50%; P.E.I. - 80%; New Brunswick - 50%; Quebec - 67%; Ontario - 50%; Manitoba - 75%; Saskatchewan - 75%; Alberta - 75%; British Columbia - 72%; Yukon Territories - 50%; Northwest Territories - 50%.
4. Pest damaged lands are assumed to regenerate naturally at a rate of 80% annually.
5. Old NSR lands, those before 1970, are assumed to regenerate at a rate of 1% annually.
6. Scarified areas are assumed to regenerate completely.
7. Percent softwood and hardwood is assumed to be the same for stocked productive nonreserved forest land.
8. Totals may not add due to rounding.

Table 2.5 Annual Accruals to Stocked Area 1975-1979

ANNUAL AREA ACCRUALS TO STOCKED LAND
1 000 ha

Province or Territory	NATURAL REGENERATION								FOREST RENEWAL			RESTOCKED AREA	% OF NATIONAL TOTAL
	Clear Cut	Partial Cut	Harvest Lands	Burns	Pest Damaged Lands	Old NSR	Scarification	Total	Planted	Seeded	Total	Total	
Newfoundland	4.80	-	4.80	1.58	27.99	2.59	0.37	37.33	0.04	-	0.04	37.37	2.1
Nova Scotia	8.86	-	8.86	0.13	25.80	0.24	1.39	36.42	2.19	0.04	2.23	38.65	2.2
Prince Edward Island	1.23	-	1.23	..	..	0.21	0.31	1.57	0.11	-	0.11	1.68	0.1
New Brunswick	27.77	-	27.27	0.24	10.18	1.59	13.12	52.90	10.15	0.21	10.36	63.26	3.6
Quebec	47.89	35.98	83.87	4.46	101.11	24.46	7.17	221.07	15.18	4.67	19.85	240.92	13.7
Ontario	38.00	55.31	93.31	50.50	210.68	20.74	38.72	413.95	28.22	25.44	53.66	467.61	26.5
Manitoba	4.00	-	4.00	100.47	4.74	9.99	4.05	123.25	0.96	0.68	1.63	124.88	7.1
Saskatchewan	4.39	-	4.39	235.23	5.82	3.25	3.21	251.90	5.30	-	5.30	257.20	14.6
Alberta	4.30	-	4.30	224.29	5.49	32.02	16.57	282.67	6.34	6.40	12.74	295.41	16.8
British Columbia	44.85	27.11	71.96	10.50	7.91	16.51	16.94	123.82	60.18	-	60.18	184.00	10.4
Yukon Territory	0.05	0.48	0.53	20.82	-	9.99	0.05	31.39	-	-	-	31.39	1.8
Northwest Territories	0.19	-	0.19	20.71	-	0.11	-	21.01	-	-	-	21.01	1.2
Canada[1]	186.33	118.88	305.21	668.93	399.72	121.71	101.72	1 597.29	128.66	37.43	166.10	1 763.39	100.0

1. Totals may not add due to rounding

Table 2.6 Annual Volume Growth from All Sources

Stocked Productive Nonreserved Forest Land

ANNUAL ACCRUALS OF GROSS MERCHANTABLE VOLUME TO GROWING STOCK
(1 000 000 m³)

Province or Territory	GROWING STOCK			NATURAL REGENERATION			FOREST RENEWAL			SILVICULTURAL TREATMENT			TOTALS		
	Swd	Hwd	All Species	Swd	Hwd	All Species	Swd	Hwd	All Species	Swd	Hwd	All Species	Swd	Hwd	All Species
Newfoundland	8.00	0.63	8.63	0.03	0.01	0.04	..	-	..	..	-	..	8.03	0.64	8.67
Nova Scotia	4.37	2.10	6.47	0.05	0.03	0.08	..	-	..	0.01	-	0.01	4.43	2.13	6.56
Prince Edward Island	0.35	0.18	0.53	..	..	..	..	-	..	-	-	-	0.35	0.18	0.53
New Brunswick	7.23	3.84	11.07	0.07	0.03	0.10	0.02	-	0.02	..	-	..	7.32	3.87	11.19
Quebec	58.16	19.65	77.81	0.26	0.09	0.35	0.03	-	0.03	..	..	..	58.45	19.74	78.19
Ontario	35.87	19.51	55.38	0.48	0.24	0.70	0.09	-	0.09	0.07	-	0.07	36.49	19.75	56.24
Manitoba	12.94	5.79	18.73	0.14	0.06	0.20	..	-	..	..	-	..	13.08	5.85	18.93
Saskatchewan	7.76	5.03	12.79	0.26	0.19	0.45	0.01	-	0.01	..	-	..	8.03	5.22	13.25
Alberta	16.08	9.75	25.83	0.36	0.15	0.51	0.03	-	0.03	..	-	..	16.47	9.90	26.37
British Columbia	102.19	5.57	107.76	0.27	0.01	0.28	0.14	-	0.14	0.04	-	0.04	102.64	5.58	108.22
Yukon Territory	2.49	0.45	2.94	0.02	..	0.02	-	-	-	-	-	-	2.51	0.45	2.96
Northwest Territories	4.84	2.02	6.86	0.01	..	0.01	-	-	-	-	-	-	4.85	2.02	6.87
Canada[1]	260.28	74.52	334.80	1.93	0.81	2.74	0.32	-	0.32	0.12	-	0.12	262.65	75.33	337.98

NOTES:

1. Totals may not add due to rounding.

Table 2.7 Accrual of Areas Relative to Source — Stocked Productive Nonreserved Forest Land

Province or Territory	ANNUAL AREA ACCRUALS	MEAN ANNUAL AREA ACCRUALS AS % OF PROVINCE/TERRITORY ACCRUALS TO STOCKED AREA		MEAN ANNUAL AREA ACCRUALS AS % OF NATIONAL ACCRUALS TO STOCKED AREA		
	1 000 ha	Forest Renewal	Natural Regeneration	Forest Renewal	Natural Regeneration	Total
Newfoundland	37.37	0.1	99.9	--	2.1	2.1
Nova Scotia	38.65	5.8	94.2	0.1	2.1	2.2
Prince Edward Island	1.68	6.5	93.4	--	0.1	0.1
New Brunswick	63.26	16.4	83.6	0.6	3.0	3.6
Quebec	240.92	8.2	91.8	1.1	12.5	13.7
Ontario	467.61	11.5	88.5	3.0	23.5	26.5
Manitoba	124.88	1.3	98.7	0.1	7.0	7.1
Saskatchewan	257.20	2.1	97.9	0.3	14.3	14.6
Alberta	296.74	4.3	95.7	0.7	16.1	16.8
British Columbia	184.00	32.7	67.3	3.4	7.0	10.4
Yukon Territory	31.39	-	100.0	-	1.8	1.8
Northwest Territories	21.01	-	100.0	-	1.2	1.2
Canada[1]	1 764.72			9.4	90.6	100.0

NOTES:

1. Total may not add due to rounding.

Table 2.8 Volume Growth Relative to Source

Stocked Productive Nonreserved Forest Land

Province or Territory	ANNUAL VOLUME GROWTH	MEAN ANNUAL VOLUME ACCRUALS AS % OF PROVINCE/TERRITORY ACCRUALS TO GROWING STOCK				MEAN ANNUAL VOLUME ACCRUALS AS % OF NATIONAL GROWTH TOTAL				
	1 000 000 m³	Growing Stock	Natural Regeneration	Forest Renewal	Silvicultural Treatment	Growing Stock	Natural Regeneration	Forest Renewal	Silvicultural Treatment	All
Newfoundland	8.67	99.5	0.5	--	--	2.6	--	--	--	2.6
Nova Scotia	6.56	98.6	1.2	--	0.2	1.9	--	--	--	1.9
Prince Edward Island	0.53	100.0	--	--	-	0.2	--	--	--	0.2
New Brunswick	11.19	98.9	0.9	--	--	3.3	--	--	--	3.3
Quebec	78.19	99.5	0.5	--	--	23.0	0.1	--	--	23.1
Ontario	56.24	98.5	1.2	0.2	0.1	16.4	0.2	--	--	16.6
Manitoba	18.93	98.9	1.1	--	--	5.5	0.1	--	--	5.6
Saskatchewan	13.25	96.5	3.4	0.1	--	3.8	0.1	--	--	3.9
Alberta	26.37	98.0	1.9	0.1	--	7.6	0.2	--	--	7.8
British Columbia	108.22	99.6	0.3	0.1	--	31.9	0.1	--	--	32.0
Yukon Territory	2.96	99.3	0.7	-	-	0.9	--	--	--	0.9
Northwest Territories	6.87	99.9	0.1	-	-	2.0	--	--	--	2.0
Canada[1]	337.98					99.0	0.8	0.1	0.1	100.0

NOTES:

1. Totals may not add due to rounding.

Table 3.1 Mean Annual Area and Volume Harvested 1975-1979 Stocked Productive Nonreserved Forest Land

Province or Territory	AREA HARVESTED[1] 1 000 ha			NET MERCHANTABLE VOLUME HARVESTED[2] 1 000 000 m³			ANNUAL HARVEST AS A % OF NATIONAL TOTAL			
							Volume			
	Clear cut	Partial Cut	Total Area	Swd	Hwd	All Species	Area	Swd.	Hwd.	All Species
Newfoundland	16.00	-	16.00	2.32	0.03	2.35	2.1	1.6	--	1.6
Nova Scotia	29.54	-	29.54	3.40	0.44	3.84	3.9	2.4	0.3	2.7
Prince Edward Island	1.64	-	1.64	0.13	0.04	0.17	0.2	0.1	--	0.1
New Brunswick	92.58	-	92.58	6.51	1.35	7.86	12.2	4.5	0.9	5.5
Quebec	159.63	35.98	195.62	26.95	4.72	31.67	25.8	18.8	3.3	22.0
Ontario	135.71	55.31	191.01	14.61	3.96	18.57	25.2	10.2	2.8	12.9
Manitoba	19.06	-	19.06	1.67	0.19	1.86	2.5	1.2	0.1	1.3
Saskatchewan	14.62	-	14.62	2.45	0.47	2.92	1.9	1.7	0.3	2.0
Alberta	21.51	-	21.51	5.98	0.11	6.09	2.8	4.2	0.1	4.2
British Columbia	149.51	27.11	176.62	67.94	0.24	68.18	23.3	47.3	0.2	47.5
Yukon Territory	0.15	0.48	0.63	0.09	--	0.09	0.1	0.1	--	0.1
Northwest Territories	0.62	-	0.62	0.08	--	0.08	0.1	0.1	--	0.1
Canada[3]	640.57	118.88	759.45	132.13	11.55	143.68	100.0	92.0	8.0	100.0

NOTES:

1. Mean Annual Area Harvested 1975-1979 from Brace and Golec 1982.
2. Gross merchantable volume less decay and cull. Mean Annual Volume Harvested 1975-1979 from Statistics Canada.
3. Totals may not add due to rounding.

Table 3.1.1 Comparison of Annual Allowable Cut and Volume of Harvest Stocked Productive Nonreserved Forest Land

Province or Territory	MERCHANTABLE VOLUME (1 000 000 m³) ANNUAL ALLOWABLE[1] CUT 1979 Swd.	Hwd.	Total	MEAN ANNUAL[2] HARVEST 1975-1979 Swd.	Hwd.	Total	MEAN ANNUAL SURPLUS OR DEFICIT Swd.	Hwd.	Total
Newfoundland	2.94	0.03[3]	2.97	2.32	0.03	2.35	0.62	-	0.62
Nova Scotia	3.27	1.40	4.67	3.40	0.44	3.84	0.13	0.96	0.83
Prince Edward Island	0.13[4]	0.04[4]	0.17	0.13	0.04	0.17	-	-	-
New Brunswick	6.79	2.67	9.46	6.51	1.35	7.86	0.28	1.32	1.60
Quebec	36.00	14.00	50.00	26.95	4.72	31.67	9.05	9.28	18.33
Ontario	26.72	15.80	42.52	14.61	3.96	18.57	12.11	11.84	23.95
Manitoba	6.08	2.27	8.35	1.67	0.19	1.86	4.41	2.08	6.49
Saskatchewan	3.50	4.16	7.66	2.45	0.47	2.92	1.05	3.69	4.74
Alberta	14.64	13.53	28.17	5.98	0.11	6.09	8.66	13.42	22.08
British Columbia	73.48[5]	0.24[3]	73.72	67.94	0.24	68.18	5.54	-	5.54
Yukon Territory	0.09[4]	-	0.09	0.09	--	0.09	0.00	--	0.00
Northwest Territories	0.08[4]	-	0.08	0.08	--	0.08	0.00	--	0.00
Canada[6]	173.72	54.14	227.86	132.13	11.55	143.68	41.59	42.59	84.18

NOTES:

1. AAC figures from Environment Canada 1981.
2. Harvest figures from Statistics Canada 1975 to 1979.
3. No AAC is published for Hardwood. These figures are the average harvest 1975-1979.
4. No AAC is published for Softwood. These figures is the average harvest 1975-1979.
5. No AAC is available for private lands outside Tree Farm Licences and for some of the remaining Old Temporary Tenures. The figure shown here includes 5 million m³ for Private Lands.
6. Totals may not add due to rounding.

Table 3.2 Mean Annual Area and Volume Burned 1977-1981

Productive Nonreserved Forest Land

Province or Territory	AREAS BURNED 1 000 ha		Average Yield[3]	GROSS MERCHANTABLE VOLUMES KILLED 1 000 000 m³			FIRE LOSSES AS A % OF NATIONAL TOTAL			
	All Forest Land[1]	Stocked Forest Land[2] 1 000 ha	m³/ha	Swd.	Volume Hwd.	All Species	Stocked Area	Volume Swd.	Volume Hwd.	All Species
Newfoundland	12.79	3.21	58.7	0.18	0.01	0.19	0.3	0.2	--	0.2
Nova Scotia	0.80	0.33	71.1	0.01	0.01	0.02	--	--	--	--
Prince Edward Island	0.19	0.01	134.4	--	--	--	--	--	--	--
New Brunswick	1.67	0.80	87.7	0.05	0.02	0.07	0.1	0.1	--	0.1
Quebec	15.34	8.31	84.6	0.55	0.18	0.73	0.8	0.6	0.2	0.9
Ontario	245.30	102.03	96.7	6.40	3.47	9.87	10.2	7.9	4.3	12.1
Manitoba	254.80	138.10	53.6	5.11	2.29	7.40	13.9	6.3	2.8	9.1
Saskatchewan	690.60	323.34	65.7	12.86	8.38	21.24	32.4	15.8	10.3	26.1
Alberta	440.16	308.30	105.5	20.32	12.21	32.53	30.9	24.9	15.0	39.9
British Columbia	51.16	29.16	204.7	5.66	0.31	5.97	2.9	6.9	0.4	7.3
Yukon Territory	91.54	41.63	51.7	1.81	0.34	2.15	4.2	2.2	0.4	2.6
Northwest Territories	917.20	41.42	32.4	0.95	0.39	1.34	4.2	1.2	0.5	1.6
Canada[4]	2 721.55	996.64	108.6	53.90	27.61	81.51	100.0	81.0	19.0	100.0

NOTES:

1. An Additional 207 440 ha were burned in National Parks and other Reserved Federal Lands. Data from Clark (1983).
2. Personal communication, G.S. Ramsey, Petawawa National Forestry Institute.
3. Average Inventory Yield from Table 1.3.
4. Totals may not add due to rounding.

Table 3.3 Depletion by Major Insects Mean Annual Volume Losses From Mortality 1977-1981 (Million m^3)

Stocked Productive Nonreserved Forest Land

Province or Territory	Spruce Budworm[1]	Forest Tent Caterpillar[2]	Misc. Defoliators[3]	Mountain Pine Beetle[4]	Spruce Beetle[5]	Eastern Larch and Misc. Beetle[6]	VOLUME LOSSES FROM INSECTS Swd.	Hwd.	All Species[8]	INSECT VOLUME LOSSES AS A % OF NATIONAL TOTAL Swd.	Hwd.	All Species
Newfoundland	3.52	--	0.50	...	--	--	3.57	--	3.57	8.0	--	8.0
Nova Scotia	3.15	--	--	...	0.50	0.20	3.85	--	3.85	8.6	--	8.6
Prince Edward Island	--	--	--	...	--	--	--	--	--	--	--	--
New Brunswick	1.62	--	0.24	...	--	0.70	1.93	--	1.93	4.3	--	4.3
Quebec	14.76	--	--	...	..	--	14.76	--	14.76	32.9	--	32.9
Ontario	11.79	0.65	--	...	..	..	11.79	0.65	12.45	26.3	1.4	27.8
Manitoba	--	--	--	...	..	..	--	--	--	--	--	--
Saskatchewan	--	--	--	...	..	..	--	--	--	--	--	--
Alberta	--	--	--	0.07	..	..	0.07	--	0.07	0.2	--	0.2
British Columbia	0.12	--	--	5.08	3.01	0.02	8.23	--	8.23	18.3	--	18.3
Yukon Territory[7]	--	--	--	...	--	..	--	--	--	--	--	--
Northwest Territories	--	--	--	...	--	..	--	--	--	--	--	--
Canada[9]	34.96	0.65	0.29	5.15	3.52	0.30	44.20	0.65	44.86	98.5	1.4	100.0

NOTES:

1. White Spruce, Black Spruce, Red Spruce, Balsam Fir, Douglas-fir.
2. Poplar, Trembling Aspen and other hardwoods.
3. Softwoods.
4. Lodgepole Pine.
5. White Spruce, Black Spruce, Red Spruce.
6. Eastern Larch, Softwoods.
7. Losses present but less than 5 000 m^3 annually.
8. Provincial pest losses are determined from internal reports of Canadian Forestry Service.
9. Totals may not add due to rounding.

Table 3.4 Depletion by Major Diseases Mean Annual Volume Losses From Mortality 1977-1981 (Million m³) Stocked Productive Nonreserved Forest Land

Province or Territory	Dwarf Mistletoes[1]	Hypoxylon Canker[2]	STEM AND ROOT DECAYS Swd.	STEM AND ROOT DECAYS Hwd.	MISCELLANEOUS DISEASES Swd.	MISCELLANEOUS DISEASES Hwd.	VOLUME LOSSES FROM DISEASES Swd.	VOLUME LOSSES FROM DISEASES Hwd.	VOLUME LOSSES FROM DISEASES All Species[3]	DISEASE VOLUME LOSSES AS A % OF NATIONAL TOTAL Swd.	DISEASE VOLUME LOSSES AS A % OF NATIONAL TOTAL Hwd.	DISEASE VOLUME LOSSES AS A % OF NATIONAL TOTAL All Species
Newfoundland	..	...	--	--	--	--	--	--	--	--	--	--
Nova Scotia	..	0.02	--	--	0.01	--	0.01	0.02	0.03	--	0.1	0.1
Prince Edward Island	..	--	--	--	--	--	--	--	--	--	--	--
New Brunswick	..	0.14	--	--	0.05	0.02	0.05	0.16	0.21	0.2	0.6	0.8
Quebec	..	1.26	--	--	..	..	--	1.26	1.26	--	4.7	4.7
Ontario	..	6.18	10.77	--	--	4.18	10.77	10.36	21.12	39.6	38.4	78.3
Manitoba	..	0.73	--	--	--	--	--	0.73	0.73	--	2.7	2.7
Saskatchewan	..	1.32	--	--	--	--	--	1.32	1.32	--	4.9	4.9
Alberta	..	0.92	--	--	--	--	--	0.92	0.92	--	3.4	3.4
British Columbia	..	--	1.40	--	--	--	1.40	--	1.40	5.2	--	5.2
Yukon Territory	...	..	--	--	--	--	--	--	--	--	--	--
Northwest Territories	...	..	--	--	--	--	--	--	--	--	--	--
Canada[4]	..	10.57	12.17	--	0.06	4.20	11.91	15.07	26.99	44.1	55.8	100.0

NOTES:

1. Lodgepole Pine, Jack Pine, Western Larch, Douglas Fir, White Spruce, Black Spruce.
2. Poplar, Trembling Aspen, other hardwoods.
3. Provincial pest losses are determined from internal reports of Canadian Forestry Service.
4. Totals may not add due to rounding.

Table 3.5 Depletion by Major Pests Mean Annual Volume Losses From Mortality 1977-1981 (Million m³) Stocked Productive Nonreserved Forest Land

Province or Territory	INSECTS		DISEASE		ALL MAJOR ORGANISMS			Area² Equivalent 1 000 ha	AREA AND VOLUME LOSSES AS % OF NATIONAL TOTAL			
	Swd.	Hwd.	Swd.	Hwd.	Swd.	Hwd.	Total¹		Area	Swd.	Hwd.	Total
Newfoundland	3.57	--	--	--	3.57	--	3.57	47.79	8.0	5.0	-	5.0
Nova Scotia	3.85	--	0.01	0.02	3.86	0.02	3.88	49.62	8.3	5.4	--	5.4
Prince Edward Island	--	--	--	--	--	--	--	--	--	--	--	--
New Brunswick	1.93	--	0.05	0.16	1.98	0.16	2.14	19.58	3.3	2.8	0.2	3.0
Quebec	14.76	--	--	1.26	14.76	1.26	16.02	157.99	26.6	20.5	1.7	22.3
Ontario	11.79	0.65	10.77	10.36	22.56	11.01	33.57	266.01	44.7	31.4	15.3	46.7
Manitoba	--	--	--	0.73	--	0.73	0.73	6.10	1.0	--	1.0	1.0
Saskatchewan	--	--	--	1.32	--	1.32	1.32	7.49	1.3	--	1.8	1.8
Alberta	0.07	--	--	0.92	0.07	0.92	0.99	7.12	1.2	0.1	1.3	1.4
British Columbia	8.23	--	1.40	--	9.63	--	9.63	32.96	5.5	13.4	--	13.4
Yukon Territory	--	--	--	--	--	--	--	--	--	--	--	--
Northwest Territories	--	--	--	--	--	--	--	--	--	--	--	--
Canada³	44.20	0.65	11.91	15.07	56.43	15.42	71.85	594.66	100.0	78.5	21.5	100.0

NOTES:

1. Volumetric totals from internal reports Canadian Forestry Service.
2. Total volume all major organisms/average yield of timber available for harvest, Table 1.3.
3. Totals may not add due to rounding.

AREA (1 000 ha)

Province or Territory	DEPLETION				SALVAGE			AVERAGE ANNUAL DEPLETION OF AREA				
	Harvest	Burn	Pests	Sub-Total	Burn[1]	Pests[2]	Sub-Total	Harvest	Burn	Pests	Total[3]	% of National Total
Newfoundland	16.00	3.21	47.79	67.00	0.06	12.80	12.86	16.00	3.15	34.99	54.14	2.4
Nova Scotia	29.54	0.33	49.62	79.49	0.08	17.37	17.45	29.54	0.25	32.25	62.04	2.8
Prince Edward Island	1.64	0.01	--	1.65	0.01	--	0.01	1.64	--	--	1.64	0.1
New Brunswick	92.58	0.80	19.58	112.96	0.20	6.85	7.05	92.58	0.60	12.73	105.91	4.8
Quebec	195.62	8.31	157.99	361.92	1.66	31.60	33.26	195.62	6.65	126.39	328.66	14.8
Ontario	191.01	102.03	266.01	559.05	1.02	2.66	3.68	191.01	101.01	263.35	555.37	25.1
Manitoba	19.06	138.10	6.10	163.26	4.14	0.18	4.32	19.06	133.96	5.92	158.94	7.2
Saskatchewan	14.62	323.34	7.49	345.45	9.70	0.22	9.92	14.62	313.64	7.27	335.53	15.1
Alberta	21.51	308.30	7.12	336.93	9.25	0.26	9.51	21.51	299.05	6.86	327.42	14.8
British Columbia	176.62	29.16	32.96	238.74	14.58	23.07	37.65	176.62	14.58	9.89	201.09	9.1
Yukon Territory	0.63	41.63	--	42.26	--	-	-	0.63	41.63	--	42.26	1.9
Northwest Territories	0.62	41.42	--	42.04	--	-	-	0.62	41.42	--	42.04	1.9
Canada[4]	759.45	996.64	594.66	2 350.75	40.70	95.01	135.71	759.45	955.94	499.65	2 215.04	100.0

NOTES:

1. Burn salvage percent as follows: Newfoundland - 2%; Nova Scotia - 25%; Prince Edward Island - 80%; New Brunswick - 25%; Quebec - 20%; Ontario - 1%; Manitoba - 3%; Saskatchewan - 3%; Alberta - 3%; British Columbia - 50%; Yukon Territory - 0%; Northwest Territories - 0%.
2. Pest damage salvage percent as follows: Newfoundland - 35%; Nova Scotia - 35%; Prince Edward Island - 40%; New Brunswick - 35%; Quebec - 20%; Ontario - 1%; Manitoba - 3%; Saskatchewan - 3%; Alberta - 4%; British Columbia - 70%; Yukon Territory - 0%; Northwest Territories - 0%; Pest salvage ≤ 90% of harvest area.
3. Depletion minus salvage.
4. Totals may not add due to rounding.

Table 3.7 Average Annual Volume Depletion from all Sources

Stocked Productive Nonreserved Forest Land

GROSS MERCHANTABLE VOLUME (1 000 000 m³)

Province or Territory	HARVEST[1]			BURN			PESTS			SALVAGE			AVERAGE ANNUAL DEPLETION						AS A % OF NATIONAL TOTAL		
	Swd	Hwd	Total	Swd	Hwd	Total	Swd	Hwd	Total	Burn[2]	Pests[3]	Sub-Total	Harvest	Burn	Pests	Swd	Hwd	All Species[4]	Swd	Hwd	All Species
Newfoundland	2.32	0.03	2.35	0.18	0.01	0.19	3.57	--	3.57	--	0.57	0.45	2.35	0.19	3.00	5.50	0.04	5.54	2.0	--	2.0
Nova Scotia	3.40	0.44	3.84	0.01	0.01	0.02	3.86	0.02	3.88	--	0.81	0.81	3.84	0.02	3.07	6.46	0.47	6.93	2.2	0.2	2.4
Prince Edward Island	0.13	0.04	0.17	--	--	--	--	--	--	--	--	--	0.17	--	--	0.13	0.04	0.17	--	--	0.1
New Brunswick	6.51	1.35	7.86	0.05	0.02	0.07	1.98	0.16	2.14	0.01	0.45	0.46	7.86	0.06	1.69	8.08	1.53	9.61	2.8	0.5	3.3
Quebec	26.95	4.72	31.67	0.55	0.18	0.73	14.76	1.26	16.02	0.04	1.92	1.96	31.67	0.69	14.10	40.30	6.16	46.46	14.0	2.1	16.2
Ontario	14.61	3.96	18.57	6.40	3.47	9.87	22.56	11.01	33.57	0.03	0.20	0.23	18.57	9.84	33.37	43.34	18.44	61.78	15.1	6.4	21.5
Manitoba	1.67	0.19	1.86	5.11	2.29	7.40	--	0.73	0.73	0.07	0.01	0.08	1.86	7.33	0.72	6.70	3.21	9.91	2.3	1.1	3.4
Saskatchewan	2.45	0.47	2.92	12.86	8.38	21.24	--	1.32	1.32	0.19	0.02	0.21	2.92	21.05	1.30	15.10	10.17	25.27	5.3	3.5	8.9
Alberta	5.98	0.11	6.09	20.32	12.21	32.53	0.07	0.92	0.99	0.29	0.02	0.31	6.09	32.24	0.97	26.06	13.24	39.30	9.1	4.6	13.7
British Columbia	67.94	0.24	68.18	5.66	0.31	5.97	9.63	--	9.63	0.90	4.04	4.94	68.18	5.07	5.59	78.29	0.55	78.84	27.2	0.2	27.4
Yukon Territory	0.09	--	0.09	1.81	0.34	2.15	--	--	--	-	-	-	0.09	2.15	--	1.90	0.34	2.24	0.7	0.1	0.8
Northwest Territories	0.08	--	0.08	0.95	0.39	1.34	--	--	--	-	-	-	0.08	1.34	--	1.03	0.39	1.42	0.4	0.1	0.5
Canada[5]	132.13	11.55	143.68	53.90	27.61	81.51	56.43	15.42	71.85	1.53	8.04	9.45	143.68	79.98	63.81	232.89	54.58	287.47	81.0	19.0	100.0

NOTES:

1. Gross merchantable volume less decay and cull.
2. Salvage at 30% of Yield for Burn Salvage Area. Tables 1.2 and 3.6.
3. Salvage at 60% of Yield for Pest Salvage Area. Tables 1.2 and 3.6.
4. Depletion minus salvage.
5. Totals may not add due to rounding.

Table 3.8 Depletion of Area Relative to Cause

Stocked Productive Nonreserved Forest Land

Province or Territory	ANNUAL AREA DEPLETION (1 000 ha)	MEAN ANNUAL AREA DEPLETION AS % OF PROVINCE/TERRITORY DEPLETION OF STOCKED AREA			AS % OF NATIONAL TOTAL			
		Harvest	Burn	Pests	Harvest	Burn	Pests	All
Newfoundland	54.14	29.6	5.8	64.6	0.7	0.1	1.6	2.4
Nova Scotia	62.04	47.6	0.4	52.0	1.3	--	1.5	2.8
Prince Edward Island	1.64	100.0	--	--	0.1	--	--	0.1
New Brunswick	105.91	87.4	0.6	12.0	4.2	--	0.6	4.8
Quebec	328.66	59.5	2.0	38.5	8.8	0.3	5.7	14.8
Ontario	555.37	34.4	18.2	47.4	8.6	4.6	11.9	25.1
Manitoba	158.94	12.0	84.3	3.7	0.9	6.0	0.3	7.2
Saskatchewan	335.53	4.4	93.5	2.2	0.7	14.1	0.3	15.1
Alberta	327.42	6.6	91.3	2.1	1.0	13.5	0.3	14.8
British Columbia	201.09	87.8	7.3	4.9	8.0	0.7	0.4	9.1
Yukon Territory	42.26	1.5	98.5	--	--	1.9	--	1.9
Northwest Territories	42.04	1.5	98.5	--	--	1.9	--	1.9
Canada[1]	2 215.04				34.3	43.1	22.6	100.0

NOTES:

1. Totals may not add due to rounding.

Table 3.9 Depletion of Volume Relative to Cause

Stocked Productive Nonreserved Forest Land

MEAN ANNUAL VOLUME DEPLETION

Province or Territory	ANNUAL VOLUME DEPLETION 1 000 000 m³			AS A % OF PROVINCE/TERRITORY FOREST LAND UTILIZED FOR TIMBER PRODUCTION DEPLETION OF STOCKED VOLUME					AS A % OF NATIONAL TOTAL					
	Swd.	Hwd.	Total	Harvest	Burn	Pests	Swds	Hwds	Harvest	Burn	Pests	Swds	Hwds	All Species
Newfoundland	5.50	0.04	5.54	42.4	3.4	54.2	99.3	0.7	0.8	--	1.1	2.0	--	2.0
Nova Scotia	6.46	0.47	6.93	55.4	0.3	44.3	93.2	6.7	1.3	--	1.1	2.2	0.2	2.4
Prince Edward Island	0.13	0.04	0.17	100.0	--	--	76.5	23.5	0.1	--	--	--	--	0.1
New Brunswick	8.08	1.53	9.61	81.8	0.6	17.6	84.1	15.9	2.7	--	0.6	2.8	0.5	3.3
Quebec	40.30	6.16	46.46	68.1	1.5	30.3	86.7	13.3	11.0	0.2	4.9	14.0	2.1	16.2
Ontario	43.34	18.44	61.78	30.1	15.9	54.0	70.2	29.8	6.5	3.4	11.6	15.1	6.4	21.5
Manitoba	6.70	3.21	9.91	18.8	74.0	7.3	67.6	32.4	0.6	2.5	0.3	2.3	1.1	3.4
Saskatchewan	15.10	10.17	25.27	11.6	83.3	5.1	59.8	40.2	1.0	7.3	0.5	5.3	3.5	8.8
Alberta	26.06	13.24	39.30	15.5	82.0	2.5	66.3	33.7	2.1	11.2	0.3	9.1	4.6	13.7
British Columbia	78.29	0.55	78.84	86.5	6.4	7.1	99.3	0.7	23.7	1.8	1.9	27.2	0.2	27.4
Yukon Territory	1.90	0.34	2.24	4.0	96.0	--	84.8	15.2	--	0.7	--	0.7	0.1	0.8
Northwest Territories	1.03	0.39	1.42	5.6	94.4	--	72.5	27.5	--	0.5	--	0.4	0.1	0.5
Canada[1]	232.89	54.58	287.47						50.0	27.8	22.2	81.0	19.0	100.0

NOTES:

1. Totals may not add due to rounding.

Table 4.1 Area Status of Forest Capital

Productive Nonreserved Forest Land

AREAS
(1 000 000 ha)

Province or Territory	LAND AREA FOR TIMBER PRODUCTION 1981				ANNUAL AREA ACCRUALS			ANNUAL AREA DEPLETION				ANNUAL AREA BALANCE	
	Stocked	N.S.R.	Undetermined	Total	Forest Renewal	Natural Regeneration	Total Regeneration	Harvest	Burn	Pests	Total	Accruals	Depletion
Newfoundland	7.88	0.47	-	8.35	--	0.037	0.037	0.016	0.003	0.035	0.054	-	0.017
Nova Scotia	2.85	0.04	-	2.89	0.002	0.036	0.038	0.030	--	0.032	0.062	-	0.024
Prince Edward Island	0.25	0.04	-	0.29	--	0.002	0.002	0.002	--	--	0.002	-	--
New Brunswick	5.89	0.29	-	6.17	0.010	0.053	0.063	0.093	0.001	0.013	0.106	-	0.043
Quebec	48.87	4.40	--	53.28	0.020	0.221	0.241	0.196	0.007	0.126	0.329	-	0.088
Ontario	33.08	3.74	-	36.82	0.054	0.414	0.468	0.191	0.101	0.263	0.555	-	0.087
Manitoba	11.83	1.80	-	13.62	0.002	0.123	0.125	0.019	0.134	0.006	0.159	-	0.034
Saskatchewan	7.36	0.59	-	7.95	0.005	0.252	0.257	0.015	0.314	0.007	0.336	-	0.079
Alberta	14.65	5.77	-	20.41	0.013	0.283	0.295	0.022	0.299	0.007	0.327	-	0.032
British Columbia	47.05	2.97	0.76	50.77	0.060	0.124	0.184	0.177	0.015	0.010	0.201	-	0.017
Yukon Territory	4.93	1.80	-	6.73	-	0.031	0.031	0.001	0.042	--	0.042	-	0.011
Northwest Territories	13.74	0.02	--	13.76	-	0.021	0.021	0.001	0.041	--	0.042	-	0.021
Canada[1]	198.36	21.91	0.76	221.03	0.166	1.597	1.763	0.759	0.956	0.499	2.215		0.452

NOTES:

1. Totals may not add due to rounding.

Table 4.2 Volume Status of Forest Capital

Productive Nonreserved Forest Land

Province or Territory	FOREST CAPITAL 1981 Stocked Volume	GROSS MERCHANTABLE VOLUME (1 000 000 m³) ANNUAL VOLUME ACCRUALS Stocked Forest	Forest Renewal	Natural Regeneration	Stand Treatment	Total	ANNUAL VOLUME DEPLETION Harvest	Burn	Pests	Total	ANNUAL VOLUME BALANCE Accruals	Depletion
Newfoundland	463.00	8.63	..	0.04	..	8.67	2.35	0.19	3.00	5.54	3.13	-
Nova Scotia	202.46	6.47	..	0.08	0.01	6.56	3.84	0.02	3.07	6.93	-	0.37
Prince Edward Island	33.32	0.53	..	..	-	0.53	0.17	..	..	0.17	0.36	-
New Brunswick	515.92	11.07	0.02	0.10	..	11.19	7.86	0.06	1.69	9.61	1.58	-
Quebec	4 132.81	77.81	0.03	0.35	..	78.19	31.67	0.69	14.10	46.46	31.73	
Ontario	3 197.60	55.38	0.09	0.70	0.70	56.24	18.57	9.84	33.37	61.78	-	5.54
Manitoba	634.37	18.73	..	0.20	..	18.93	1.86	7.33	0.72	9.91	9.02	-
Saskatchewan	484.02	12.79	0.01	0.45	..	13.25	2.92	21.05	1.30	25.27	-	12.02
Alberta	1 544.73	25.83	0.03	0.51	..	26.37	6.09	32.24	0.97	39.30		12.93
British Columbia	9 627.95	107.76	0.14	0.28	0.04	108.22	68.18	5.07	5.59	78.84	29.38	-
Yukon Territory	254.55	2.94	-	0.02	-	2.96	0.09	2.15	..	2.24	0.72	-
Northwest Territories	445.58	6.86	-	0.01	-	6.87	0.08	1.34	..	1.42	5.45	-
Canada[1]	21 536.31	334.80	0.32	2.74	0.12	337.98	143.68	79.98	63.81	287.47	50.51	-

NOTES:

1. Totals may not add due to rounding.

Table 4.3 Softwood Volume Status

Productive Nonreserved Forest Land

Province or Territory	GROSS MERCHANTABLE VOLUME OF SOFTWOODS (1 000 000 m³) FOREST CAPITAL 1981 Stocked Volume	ANNUAL VOLUME ACCRUALS Stocked Forest	Forest Renewal	Natural Regeneration	Stand Treatment	Softwood Total	ANNUAL VOLUME DEPLETION Harvest	Burn	Pests	Softwood Total	ANNUAL VOLUME BALANCE Accruals	Depletion
Newfoundland	428.89	8.00	--	0.03	--	8.03	2.32	0.18	3.00	5.50	2.53	-
Nova Scotia	136.86	4.37	--	0.05	0.01	4.43	3.40	0.01	3.05	6.46	-	2.03
Prince Edward Island	22.23	0.35	--	--	-	0.35	0.13	--	--	0.13	0.22	-
New Brunswick	337.58	7.23	0.02	0.07	--	7.32	6.51	0.04	1.53	8.08	-	0.76
Quebec	3 089.28	58.16	0.03	0.26	..	58.45	26.95	0.51	12.84	40.30	18.15	-
Ontario	2 074.72	35.87	0.09	0.46	0.07	36.49	14.61	6.37	22.36	43.34	-	6.85
Manitoba	438.58	12.94	--	0.14	--	13.08	1.67	5.03	--	6.70	6.38	-
Saskatchewan	293.47	7.76	0.01	0.26	--	8.03	2.45	12.65	--	15.10	-	7.07
Alberta	964.91	16.08	0.03	0.36	--	16.47	5.98	20.03	0.05	26.06	-	9.59
British Columbia	9 131.88	102.19	0.14	0.27	0.04	102.64	67.94	4.76	5.59	78.29	24.35	-
Yukon Territory	214.63	2.49	-	0.02	-	2.51	0.09	1.81	--	1.90	0.61	-
Northwest Territories	314.71	4.84	-	0.01	-	4.85	0.08	0.95	--	1.03	3.82	-
Canada[1]	17 447.74	260.28	0.32	1.93	0.12	262.65	132.13	52.34	48.42	232.89	29.76	-

NOTES:

1. Totals may not add due to rounding.

Table 4.4 Hardwood Volume Status

Productive Nonreserved Forest Land

Province or Territory	GROSS MERCHANTABLE VOLUME OF HARDWOODS (1 000 000 m³) FOREST CAPITAL 1981	ANNUAL VOLUME ACCRUALS					ANNUAL VOLUME DEPLETION				ANNUAL VOLUME BALANCE	
	Stocked Volume	Stocked Forest	Forest Renewal	Natural Regeneration	Stand Treatment	Hardwood Total	Harvest	Burn	Pests	Hardwood Total	Accruals	Depletion
Newfoundland	34.11	0.63	-	0.01	-	0.64	0.03	0.01	--	0.04	0.60	-
Nova Scotia	65.60	2.10	-	0.03	-	2.13	0.44	0.01	0.02	0.47	1.66	-
Prince Edward Island	11.10	0.18	-	--	-	0.18	0.04	--	--	0.04	0.14	-
New Brunswick	178.34	3.84	-	0.03	-	3.87	1.35	0.02	0.16	1.53	2.34	-
Quebec	1 043.53	19.65	-	0.09	--	19.74	4.72	0.18	1.26	6.16	13.58	-
Ontario	1 122.88	19.51	-	0.24	-	19.75	3.96	3.47	11.01	18.44	1.31	-
Manitoba	195.80	5.79	-	0.06	-	5.85	0.19	2.29	0.73	3.21	2.64	-
Saskatchewan	190.55	5.03	-	0.19	-	5.22	0.47	8.38	1.32	10.17	-	4.95
Alberta	579.82	9.75	-	0.15	-	9.90	0.11	12.21	0.92	13.24	-	3.34
British Columbia	496.06	5.57	-	0.01	-	5.58	0.24	0.31	--	0.55	5.03	-
Yukon Territory	39.92	0.45	-	--	-	0.45	--	0.34	--	0.34	0.11	-
Northwest Territories	130.87	2.02	-	--	-	2.02	--	0.39	--	0.39	1.63	-
Canada[1]	4 088.58	74.52	-	0.81	-	75.33	11.55	27.61	15.42	54.58	20.75	-

NOTES:

1. Totals may not add due to rounding.

Table 4.5 Forest Capital Lying Idle: Area and Volume Growth Not Realized — Productive Nonreserved Forest Land

Province or Territory	FOREST CAPITAL LYING IDLE 1981	ANNUAL GROWTH NOT REALIZED ON BACKLOG OF NSR LANDS		AVERAGE ANNUAL INCREASE IN IDLE NSR LANDS
	Area 1 000 000 ha	MAI_T $m^3/ha/a$	Volume 1 000 000 m^3	Area 1 000 000 ha
Newfoundland	0.47	1.1	0.52	0.017
Nova Scotia	0.04	2.3	0.10	0.024
Prince Edward Island	0.04	2.1	0.08	--
New Brunswick	0.29	1.9	0.55	0.043
Quebec	4.40	1.6	7.04	0.088
Ontario	3.74	1.7	6.36	0.087
Manitoba	1.80	1.6	2.88	0.034
Saskatchewan	0.59	1.8	1.06	0.079
Alberta	5.77	1.8	10.39	0.032
British Columbia	2.97	2.3	6.83	0.017
Yukon Territory	1.80	0.6	1.08	0.011
Northwest Territories	0.02	0.5	0.01	0.021
Canada[1]	21.91	1.7	38.15	0.452

NOTES:

1. Totals may not add due to rounding.